Analytic Support to the Battle Command Battle Laboratory

FY94 Battle Command Advanced Warfighting Experiments

Final Briefing Report

Army Research Institute ......TRADOC Analysis Center

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Mission

The Fiscal Year (FY) 94 Battle Command Advanced Warfighting Experiments (AWEs) were conducted from January through May 1994 by the Battle Command Battle Laboratory (BCBL) at Fort Leavenworth, Kansas. The experiments were used as a means to investigate BCBL's assigned Louisiana Maneuvers (LAM) '94 issue, "Holistic Review of Command, Control, Communications, Computers, and Intelligence (C4I)". Objectives of the LAM issue focused on the relevant common picture (RCP) -- a view of the battlefield required by the division commander and shared by his staff and subordinate units. Specifically, BCBL was tasked to determine the components of the RCP for the division commander; develop a prototype means of delivering the RCP; and describe the impact of the RCP on the Commander of the Mobile Strike Force (MSF), as a surrogate division commander, during the Command and General Staff College (CGSC) annual student exercise, Prairie Warrior. This summary was developed by the Training and Doctrine Command (TRADOC) Analysis Center (TRAC) and the Army Research Institute (ARI), and provides results of analyses conducted in support of BCBL during and subsequent to the AWEs.

Mission

Provide analytic support to BCBL for investigation of LAM '94 issue - Holistic Review of C4I

BCBL Objectives

Determine components of the RCP to support combat operations at division level

Develop prototype Battle Command Support System for a division commander

Describe impact of the RCP on the MSF Commander during Prairie Warrior

✔ ***Relevant Common Picture (RCP) focus***

Outline

The report includes the study background and a section on each of the three BCBL objectives. It also addresses two secondary issues, providing a think-piece on the 21st century classroom and an assessment of the AWE process. Key conclusions and recommendations across all experiments are provided in the summary.

Outline

- *Background*
- *Relevant Common Picture*
- *Battle Command Support System*
- *Impact on the MSF Commander*
- *21st Century Classroom*
- *AWE Process*
- *Summary*

Background

The background section discusses the study context, identifies the overall approach and supporting simulations, and highlights key participants in the AWEs. Major assumptions and limitations of the AWEs are noted. Specific assumptions and limitations which are relevant to the three principal analytic efforts are reinforced in those separate sections of the briefing report.

Background

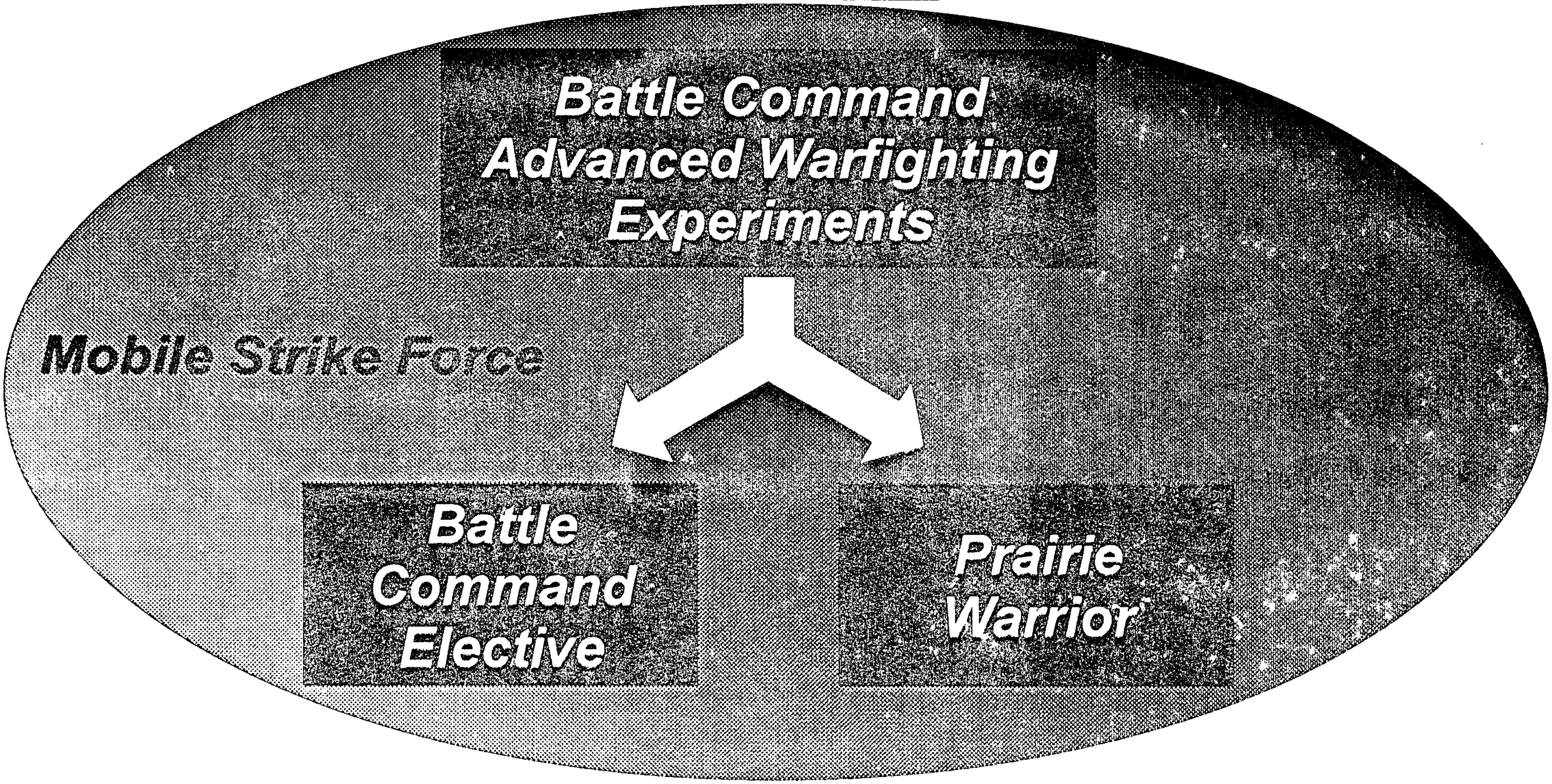
- *Context*
  - *Approach*
    - *Simulation Support*
      - *Participants*
        - *Assumptions*
          - *Limitations*

Context

BCBL designed the AWEs within the context of two activities associated with CGSC. These were the Battle Command Elective (BCE), a pilot course developed jointly by BCBL and CGSC, and the annual Prairie Warrior student exercise conducted by the college in May. Throughout the experiments, CGSC students participated as key leaders and staff of the MSF. This experimental force is used by the Army to investigate and develop future concepts and organizations leading the Army to the 21st century, through interactions with leaders who will be senior Army leaders in a time frame when such a force might be fielded. The MSF has been used in other Army ventures as an exploratory construct. This particular MSF was designed by the TRADOC Battle Laboratory Integration, Technology and Concepts Directorate (BLITCD), and is characterized as a 1998+ division-sized force.

This setting provided an environment for exploration of some secondary experimentation issues. The unique association of BCBL and CGSC introduced students to some teaching concepts and tools not used throughout the CGSC curriculum. Observation of this process may be useful in the design of the 21st century classroom. The other secondary issue involved the AWE process itself -- strengths, weaknesses, and areas for improvements, since it represented a different way of investigating warfighting issues.

Context



Secondary experimentation issues

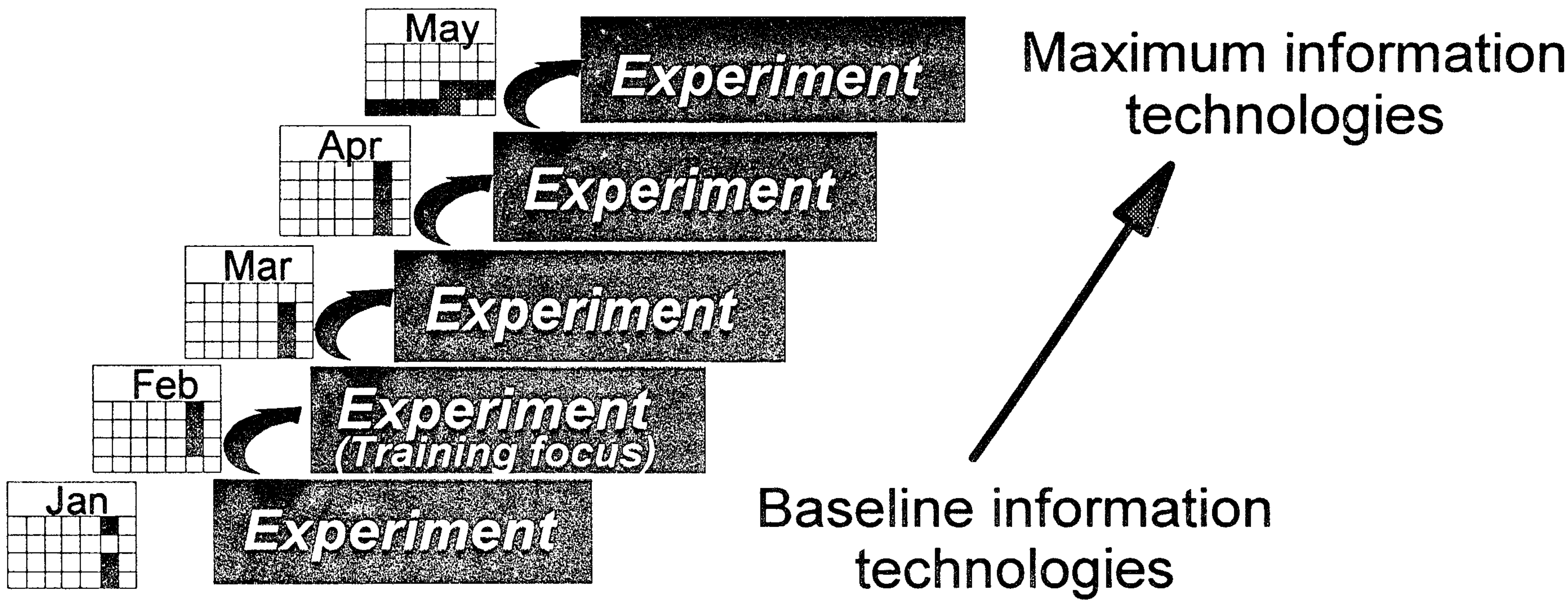
- *Explore 21st Century classroom concepts*
- *Evaluate the AWE process*

Approach

BCBL's initial concept called for five AWEs to be held from January through May 1994, one each month. Associated with each AWE was a warfighting exercise which provided a set-piece for exploring the relevant common picture. The experiments during the first four months comprised the BCE, and the May experiment was a subset of the Prairie Warrior exercise. The exercises began from a baseline of limited information technology and moved towards a digitized force, to investigate and identify components of the RCP and useful capabilities to contribute to the development of that picture. The experiences of the first AWE caused a shift in focus towards information technology training during the second AWE. Warfighting exercises resumed with the March experiment. In addition to the warfighting exercises, a series of seminars provided information on battle command, information technologies, and warfighting concepts for the MSF.

With each AWE, the MSF staff received a mission order, and developed plans to execute their assigned mission. The MSF Commander directed battle operations from a forward command post (CP), with selected key staff members; the remainder of the headquarters staff was located in a rearward CP, and conducted planning operations from that location. Subordinate commanders within the MSF were also physically separated from the forward and rearward CPs.

Approach



- *Warfighter exercises*
- *Expansion of information technologies with each experiment*
- *Increased complexity of mission with each warfight*
- *Focused seminars*

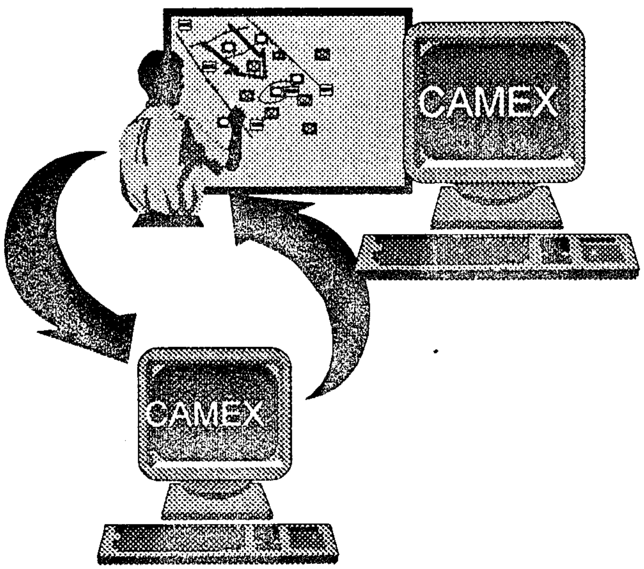
Simulation Support

Three simulation drivers were used in the experiments. The Computer-Assisted Map Exercise (CAMEX) model, developed and operated by TRAC, served as the exercise driver in January and March. In April, the JANUS model was used in conjunction with an archived National Training Center (NTC) scenario depicting a brigade-level operation. Operators were provided by CUBIC Applications, Incorporated, for the April exercise, with the simulation inputs built by TRAC's Monterey office. During the May experiment, the Corps Battle Simulation (CBS) and associated confederation of models were used as the MSF students joined the rest of the CGSC students for Prairie Warrior. The National Simulation Center (NSC) provided the CBS model.

CAMEX was also used as a course of action (COA) evaluation tool in March, supporting BCE students, and in April, supporting Advanced Tactics students planning the MSF operation for Prairie Warrior. In May during the actual Prairie Warrior exercise, both CAMEX and a prototype COA tool provided by NSC were used to support the MSF.

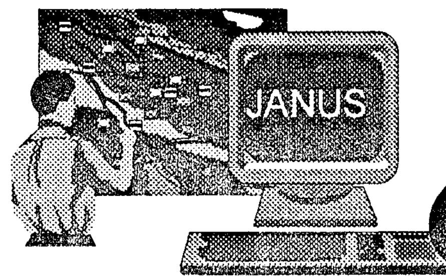
Simulation Support

BCE
Jan-Mar 94

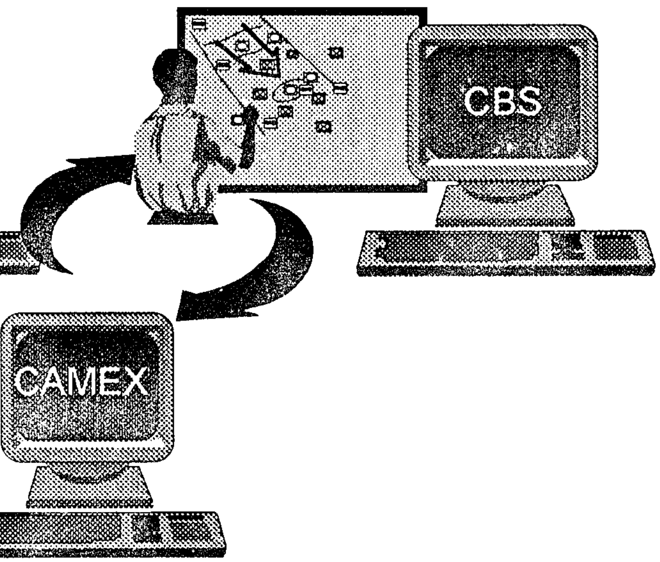


COA evaluation support for BCE exercise

BCE
Apr 94



Prairie Warrior
May 94

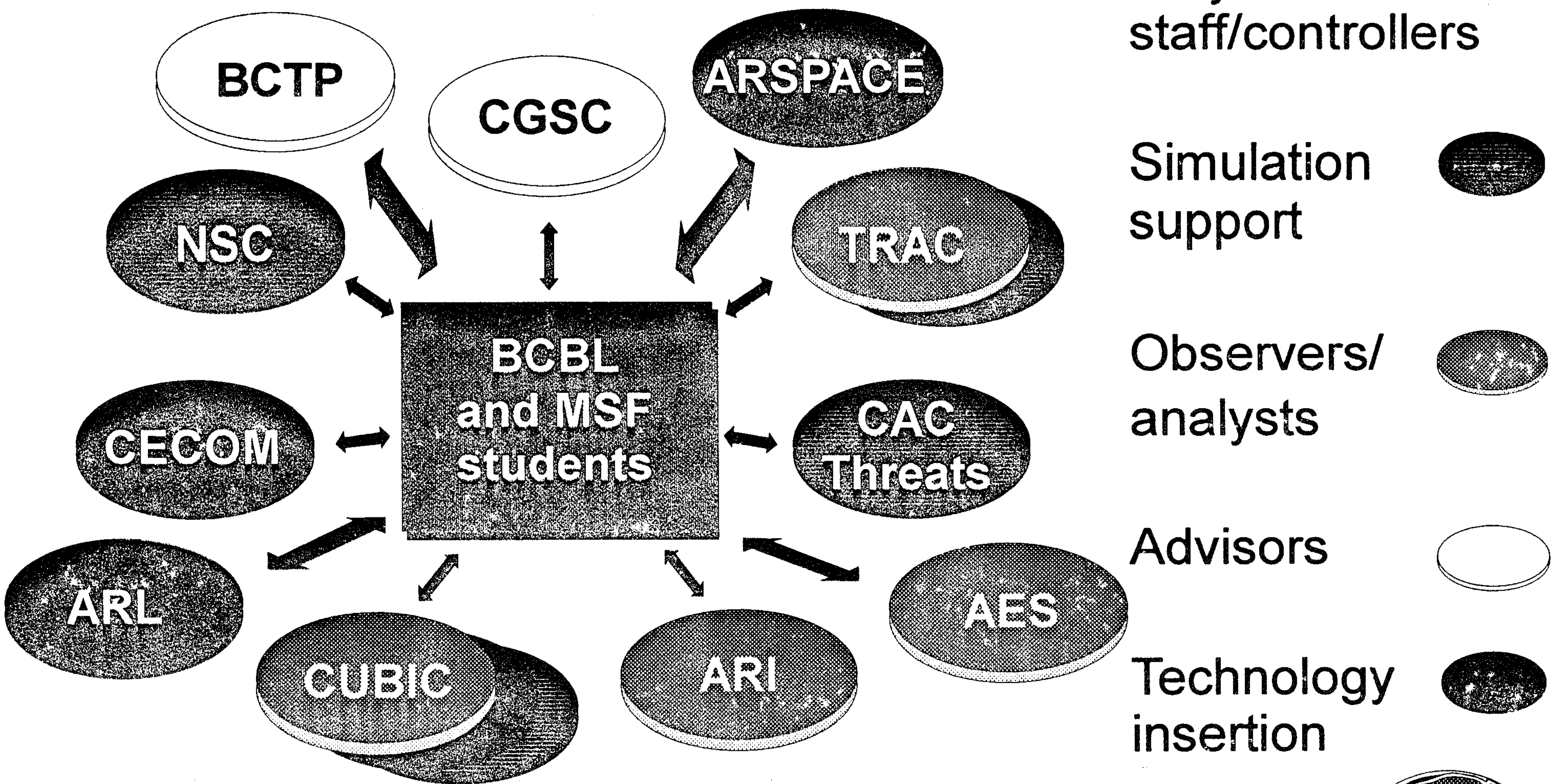


COA evaluation support for Advanced Tactics Elective

Participants

The experiments were conducted by BCBL's Experimentation Division. BCBL project officers designed the experiments, developed the structure for each class meeting, coordinated all support requirements, served as controllers for the exercises, and facilitated seminars and discussions. CGSC supported the exercises with student participants, and also provided instructors to assist BCBL in doctrinal issues, staff procedures, and educational and administrative requirements for the BCE. Analysis support was provided by TRAC and ARI; TRAC also provided simulations to serve as exercise drivers. CUBIC provided integrating support under a contract with BCBL, including observation support, simulation support, and technology insertion. NSC provided facilities for the experimentation, and supported the May exercise with CBS. Communications and Electronics Command (CECOM) assisted BCBL with identification and integration of information technologies in the experiments. Combined Arms Center (CAC) Threats represented the opposing force (OPFOR) for the experiments through April, with the Battle Command Training Program (BCTP) World Class OPFOR providing that function in the Prairie Warrior exercise. The Army Tactical Command and Control System (ATCCS) Experimentation Site (AES) assisted in the data collection effort with technicians and recording equipment for video, audio, and computer monitoring. Finally, U.S. Army Space Command (ARSPACE), Army Research Laboratory (ARL), and several other Army Research, Development and Engineering Centers (RDECs), laboratories, and defense contractors provided prototype systems to allow exploration of information technologies to enhance battle command.

Participants



Assumptions

CGSC students are central participants in the Army's efforts to identify requirements for the 21st century. The Chief of Staff, U.S. Army (CSA) is driving the Army to "place" itself in the future and look back to chart the steps to achieve that vision. A key assumption in this approach is that CGSC students have the requisite knowledge and experience to represent a future division commander and staff, make appropriate decisions, and envision the information requirements for future warfighting.

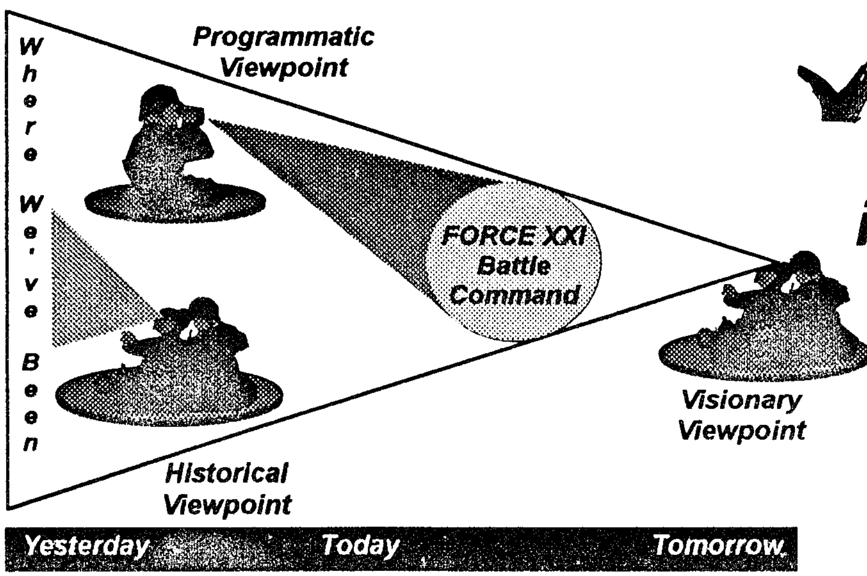
Further, the students did not come into the exercises as a cohesive staff, and the BCE classes provided the only formal opportunity for this ad hoc group to come together as a functioning unit. It was assumed this result would occur.

The AWEs were structured with the assumption that students were familiar with CGSC's tactical standing operating procedures (SOPs) for a division, and with the use of personal computers. The strain on these assumptions seen in January caused a restructuring of the February experiment to address training needs.

Assumptions

CGSC BCE students:

- Have adequate knowledge and experience to envision division commanders' information requirements for future warfighting
- Have adequate opportunities through the BCE for team building and staff cohesion
- Are fundamentally competent in tactical SOPs
- Have an adequate level of computer literacy



CGSC students are appropriate participants in achieving CSA's goal -- Create a vision and pull the Army to it!

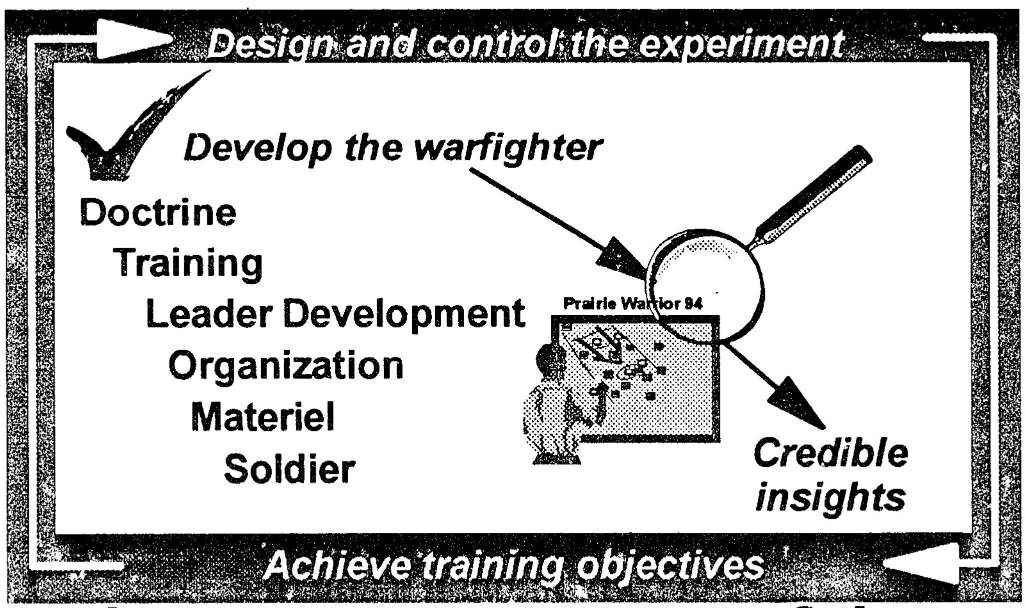
Limitations

The merger of research about future warfighting with current training exercises brings a special challenge to the Army, illustrated here. The challenge is to design experiments to accommodate research objectives within the context of a training exercise, without undermining the training value of the exercise. In the pilot programs of the Battle Command AWEs, new ideas were introduced to CGSC student warfighters across most of the TRADOC domains of doctrine, training, leader development, organization, materiel, and soldiers (DTLOMS). While this approach may be a useful way to get a program off the ground, it also detracts from the ability to really isolate cause and effect relationships of interest in the investigations and may detract from the training objectives. The BCE served as a mechanism to provide specific research-related training, but competing objectives and limited classroom time did not allow full achievement of warfighter competencies across the DTLOMS, considering that the MSF was a new organization with new equipment and no employment concept until past the midway point of the course. The initial course objectives had to be adjusted to allow student exposure to domains outside of BCBL's area of interest. Use of prototype technologies and linkages were necessary in the experimentation, but the linkages were inadequate to provide a rigorous assessment of the contributions of information technologies. Finally, the austere staffing of the MSF with 28 BCE students and approximately 120 augmentees for Prairie Warrior did not permit a valid, comprehensive investigation of staff sizes, staff processes, or CP designs for a division-sized unit. Therefore any reported observations of events related to these areas should only be used as a basis for further investigation, not as a basis for change. As an example, investigations of hierarchical versus internetted processes are limited to a characterization of the way the MSF staff used common means of communications; these results do not establish division requirements for communications capabilities.

Limitations

- Pilot program, learning process for experimenters and participants
- Competing objectives - training versus experimentation
- Limited class size (28) and classroom time (18 hours per month)
- Prototype technologies and linkages - not ideal surrogates for objective digitization capabilities
- Many division functions not represented - insights on staff process and CP design are based on opportunistic observations

Inadequate training across the DTLOMS



Insights useful for informing further investigations

Mandates an assessment of the process!

Relevant Common Picture

This section details the support to BCBL's mission to determine the required RCP for the division commander. The section is organized as shown.

Relevant Common Picture

- *Focus*
  - *Information Sources and Data Elements*
    - *Hypotheses*
      - *Methodology*
        - *Results*
          - *Recommended Core Set of Information Elements for the RCP*
            - *Other Considerations for the RCP*
              - *Conclusions and Recommendations*

Focus

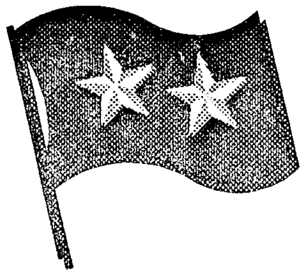
BCBL's objective for the RCP is stated here. Two definitions add clarity to this objective:

Common Picture: The common picture of the battlefield is the aggregate of data shared among all friendly forces on the disposition of the friendly and enemy force. With a common picture of the battlefield, commanders and staff in the force all have the same information at the same time. Digitization of the battlefield, the horizontal and vertical integration of friendly battle command and information systems, is an enabler of the common picture.

Relevant Common Picture: The RCP provides the commander a comprehensive view of his unit's battlespace, consisting of a graphical portrayal of enemy and friendly situation, commander-selected status, and horizontal integration of the battlefield information systems. The emphasis is on "selected", in that the RCP is a slice of all that which is available to the force. The relevancy is related to and dictated by the situation and mission, and the RCP typically increases in detail shown as the echelon served is closer to the soldier. This is also termed situational awareness.

To help BCBL meet their objective, the study team established the analytical objective of identifying the elements of information the division commander requires to support his decisionmaking process. These elements can be supplied by various sources: commander's staff; subordinate, higher, adjacent, and other unit command and staff; intuition; and others. This effort is tailored to developing the RCP for the division commander, although there may be differing RCP requirements through the force, depending on the echelon. The orientation here is also on a maneuver commander, although other functional area commanders may have a different set of requirements.

Focus



BCBL Objective

Determine the components of the RCP to support combat operations at division level

Analysis Issue

What are the necessary elements of information required for decisionmaking by the division commander?

Information Sources

Three basic information sources were used to develop recommendations for the RCP.

The TRAC-developed BCE student questionnaire was a significant contributor to the data base. The questionnaire was administered twice. Its purpose was to elicit student perceptions regarding various information types and information systems provided to them during the baseline experiment in January and during the "technology-insertion" experiment in March.

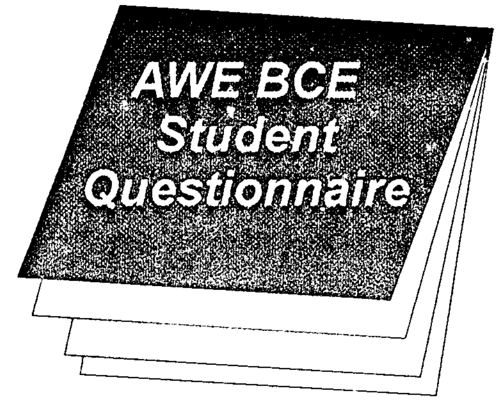
Direct observations were very important to the analytic effort. These observations were made in three types of events:

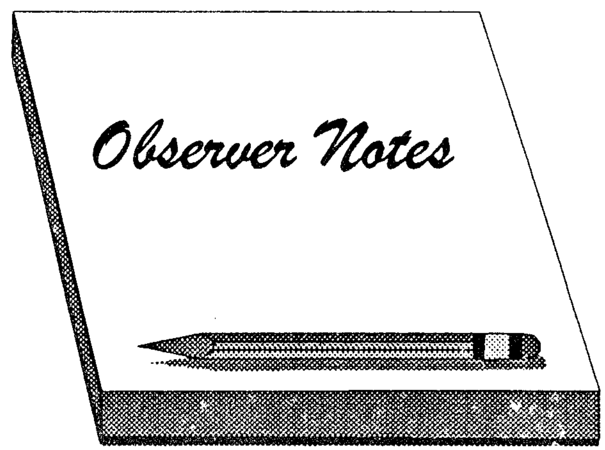
- The warfighting exercises (including January, March, April and Prairie Warrior in May).
- The BCE seminars presented throughout the five months.
- After-Action Reviews (AARs) conducted subsequent to the AWE exercises.

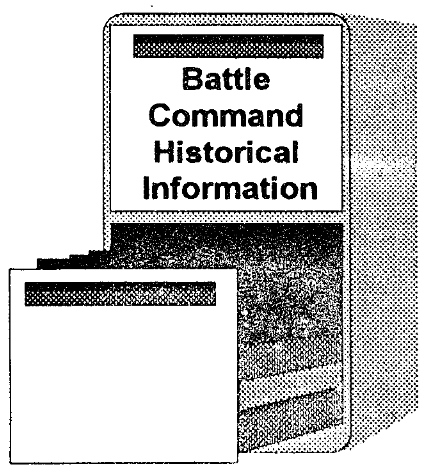
Historical information provided a requisite background for the study team. This information included doctrinal literature on battle command and tactical decisionmaking, which was necessary to achieving an understanding of the baseline battle command system and the command and staff procedures implemented by CGSC students during the exercise. The historical literature also included a 1985 study on Commander's Critical Information Requirements (CCIR). As it turned out, the CCIR Study proved a significant source of data which led to expansion of the data collection and analysis plan, and greatly enhanced overall study results.

Information Sources

- BCE student questionnaires
- Data collector observations
  - AWE exercises
  - Seminars
  - AARs
- Historical information
  - Doctrine
  - CCIR Study







Data Elements

Various data elements were derived from each information source. Student questionnaires were probably the most significant source of data to determine the required elements of information for the RCP. The questionnaires elicited several characteristics (adequacy, criticality, frequency of use, and timeliness) from the students regarding 16 information types. These information types included friendly and enemy force data (seven elements for each) and two types of geophysical data, as shown. The perceived criticality and frequency of use of these information types were used directly to determine the elements of the RCP.

Direct observation data on information types, frequency of use, and entities involved in the information exchange were recorded by data collectors as observed during the exercises and subsequently, while reviewing video recordings of command and staff activities. It was possible to record much more data from review of the taped events than from real-time observation, because of the pace of activity in the cells during the exercises.

As part of the historical information, the 1985 CCIR study provided a "strawman" set of information elements as a basis for a core set of RCP elements. In a merger of student questionnaires with historical information, the March questionnaires also elicited a rank-ordering of these information elements potentially comprising the RCP. General officer respondents' comments to the original study were comprehensive and addressed many analytical and doctrinal concerns, such as seeming redundancy or lack of precision of some elements. The study team agreed with the comments, but kept the 1985 list intact to maintain consistency between the two efforts and permit statistical testing on the rank ordering of the elements in the two sets. Students were asked to assess the 83 information elements from the 1985 CCIR Study, as sure inclusions, sure exclusions, or possible inclusions to a set of CCIR. Students were asked to limit each set to one comprised of about one-third of these elements. The 1985 study identified 25 information elements as the minimum essential elements required for commander's decisionmaking. The study team established 25 as a cut line to provide a linkage with the prior study. The team believed that identifying a set of about one-third of the elements as CCIR would ensure a strong 25 essential elements.

Data Elements

Criticality & frequency of these information types

BCE Student Questionnaires

Enemy & Friendly Force

- Location
- Activity
- Strength
- Logistics status
- Intent
- Capabilities
- Equipment types

Geophysical Data

- Terrain
- Weather

Data Collector Observations

- Information type used
- Frequency of use
- Receiver-Sender

Historical Information

- Battle command doctrinal literature
- Ranked CCIR elements (existing rankings and new student rankings)

Hypotheses

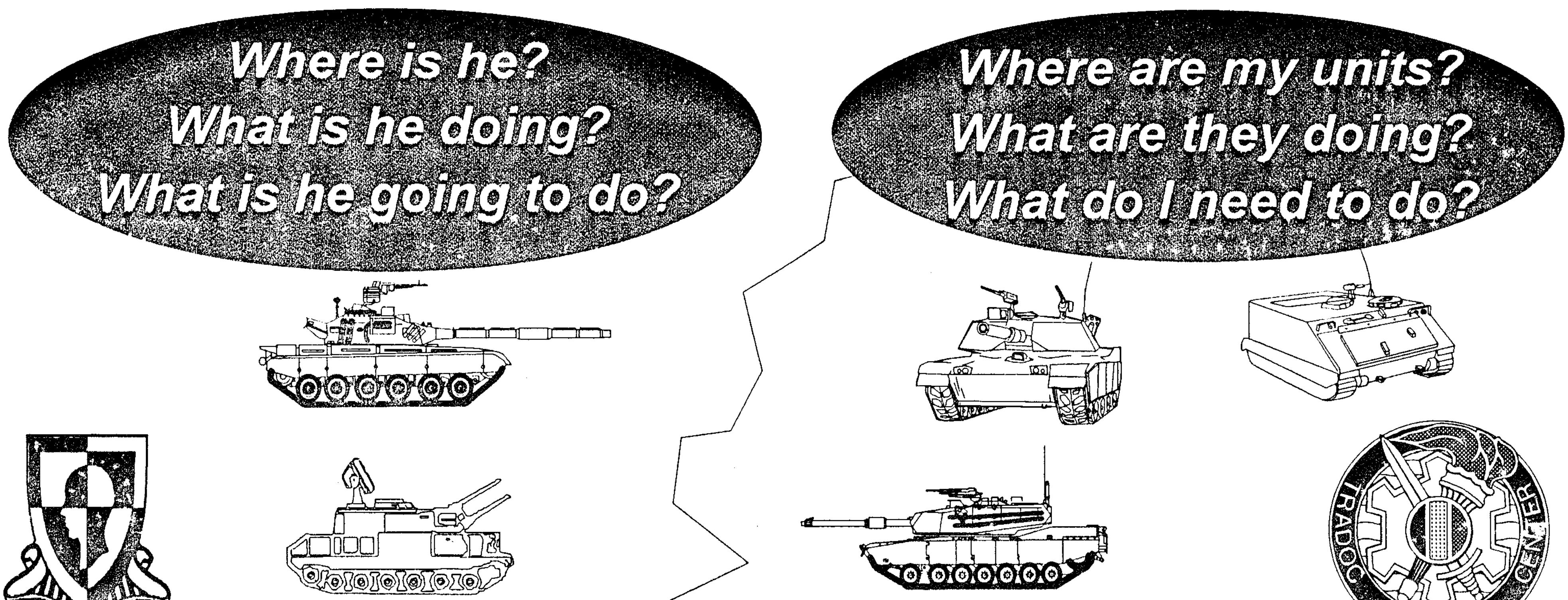
The study team had three hypotheses regarding the development of the RCP. The first hypothesis was that the CGSC student population is, in fact, an appropriate sample of the Army officer population to use to develop or refine the RCP. This hypothesis is important because the BCE students are used to support the Battle Lab in its efforts to investigate and advance the art of battle command. It is important that they are an appropriate group for this purpose. They were expected to perform command and staff functions in a doctrinally sound manner, so that observations had a strong basis.

The second hypothesis was that the Army has previously identified an adequate core set of information elements to comprise the RCP. This hypothesis was supported by the 1985 CCIR Study, by combat developments work related to the development of an Army command and control system, and by modeling efforts for the various ATCCS systems, with doctrinally-required information elements identified in model design efforts.

The study team also believed, as a third hypothesis, that there are several most critical information elements to the division commander's RCP. Regarding the enemy force the commander needs to know where he is, what he's doing, and what he's going to do. With regard to his own forces, the commander needs to know where his units are, what they are doing, and what they need to do -- in other words, these few elements are the essence of situational awareness.

Hypotheses

- CGSC students are appropriate to use to develop the RCP
- Army has an adequate core set of RCP information elements
- Critical information elements have a historical basis and continue to be:



Methodology

Overall AWE assumptions and limitations that were important in this effort include the small BCE class size (28) and the use of student warfighters for this task. The methodology provided a way to assess the validity of student judgments through comparisons with seasoned warfighters. A three step process was used to test the hypotheses. The first step involved data comparisons in three areas. The study team compared the perceived frequency and actual frequency of information usage by the type of information, to assess the appropriateness of using CGSC students as a source for the experiment. The team also made a comparison of the BCE ranking of 83 information elements versus the general officer CCIR study ranking of the same elements, to determine whether the rankings of critical information elements differed across two groups with very different levels of experience and an intervening decade. As a final step in the comparison process, the team compared the perceived criticality of the 16 information types and equivalent CCIR elements derived from the list of 83, to affirm whether a basic, critical set was consistently identified.

Next, the common and core elements required for the RCP were determined. This was accomplished by merging the information elements, setting a limit of 25 elements as the number for a core set. The identification of the top 25 in each set would most likely result in some elements common to the top 25 of both sets, some elements which would occur in the top 25 of the BCE ranking, and some which would be found only in the top 25 of the CCIR ranking. Further, insertion of additional elements from data collector observation - of AWEs, AARs, and seminars, was allowed. This was to provide additional objectivity to the process.

The final step validated the information element set. This was accomplished by re-examining the set of elements identified for the relevant common picture and ensuring that each element had a doctrinal basis.

Methodology

- ***Conduct comparisons***
  - Perceived and actual frequency of information usage by type
  - BCE ranking of 83 information elements versus CCIR ranking
  - Perceived criticality of 16 info types and equivalent CCIR elements

Students are an appropriate source?

CCIR requirements are stable?

Critical, basic set of requirements exists?

- ***Determine core elements by considering:***
  - Merging information elements by ranking
  - Inserting additional elements from observation
    - AWEs/AARs/seminars
- ***Validate Set***

Investigation limited to responses of 28 student warfighters and 10 observers

Results - Questionnaire Comparisons

To assess whether students were an appropriate source of information, the study team sought to establish whether student judgments or perceptions about events were consistent with actual events. The study team examined the correlation of the students' perception of the frequency of usage of information types and the data collector observations of frequency. The data collector observations of frequency were made, as stated earlier, both real-time during the exercises and subsequently from the video-recorded tapes of the warfighting exercises. The basic result of this examination was that the students' perceptions of reality were highly accurate. Thus, the students were appropriate to use for perceptions of criticality of information types, and for their perceptions of elements required to support a division commander's decisionmaking.

Having established a basis for using student judgments, and believing the general officer survey also had a certain degree of credibility attached to it, the study team analyzed the BCE and general officer CCIR rankings of information elements by using the statistical technique of Spearman rank correlation. This technique examines the correlation between the rank orderings of elements comprising two data sets. In this case the team found that the correlation between the two sets was highly significant (99% confidence level). Thus, there was no statistical difference between the rank ordering of the elements. To report the equivalence of the rankings in a more intuitive way, the commonality of elements between the two sets was examined. That is, the study team examined how many information elements in the BCE top 10, 16, and 21 elements occurred in the top 10, 16, and 21 of the CCIR study. This commonality reflected the strength of the Spearman statistic, with 5 of 10, 11 of 16, and 17 of the top 21 elements common to the two sets. This result validates the use of the information elements identified by these sets as a core for the division commander's RCP.

To take full advantage of data from the student questionnaire, the study team examined the correlation between the perceived criticality of the 16 information types and equivalent CCIR elements. There was a high correlation for both the January and March responses. This provided further evidence that students' responses were consistent regarding criticality, and hence, lends further credibility to their rankings of information elements.

Results - Questionnaire Comparisons

- ***Comparison of BCE student perceptions and BCE actual observed frequency of information usage by type***
  - Student set highly correlated (98% CL)
  - Data collector set highly correlated (99% CL)
- ***Comparison of BCE student and CCIR general officer rankings of 83 elements***
  - No statistical difference (99% CL)
  - Significant commonality of information elements
    - 5 of Top 10
    - 11 of Top 16
    - 17 of Top 21
- ***Comparison of BCE student perceptions of criticality of 16 info types and equivalent BCE student rankings of CCIR elements***
  - January responses highly correlated (99% CL)
  - March responses correlated (87% CL)

✓ Assess validity of student judgments

✓ Confirm stability in CCIR

✓ Verify criticality of information

CL = confidence level

Results - Important Information Types

The information types rated as important to essential (4 or 5 on a 1 to 5 scale) by the BCE students are shown in order of rating, starting with friendly location as the highest, friendly intent as the next highest, etc. The friendly types included the additional strength and capabilities categories, while both friendly and enemy types included location, intent, and activity. Both geophysical types, terrain and weather, were rated important in the second survey. Weather, however, did not average the important rating in January or for the two surveys combined. Since the March "technology-insertion" experiment was seen as the more important context for the responses, weather was incorporated in the set. All other information types listed here averaged important (4) or higher in both surveys.

Friendly location and intent, and enemy location were notably higher than the other types in both the January and March survey responses.

This survey provides evidence supporting initial hypotheses about the issues a commander must continually address: friendly and enemy location, intent, and activity.

Results - Important Information Types

- ***Information types rated <u>important to essential</u> by students***

- Friendly
  - Location
  - Intent
  - Activity
  - Strength
  - Capabilities
- Enemy
  - Location
  - Intent
  - Activity
- Geophysical
  - Terrain
  - Weather

Where are my units?
What are they doing?
What do I need to do?

Where is he?
What is he doing?
What is he going to do?

✓ ***High-ranking categories are also reflected in detailed results***

Recommended Core Set of Information Elements for the RCP

The 18 elements shown here were common to the top 26 elements of both the BCE student and general officer rankings of the 83 candidate information elements. The elements are provided in order of importance according to BCE student rankings. The study team drew the cut line at 26 because of a tie in the rankings for the 25th element in the BCE set. Again, the reason to draw the line for the CCIR set at 25 elements was to maintain consistency with the CCIR study.

There is a strong parallel between these elements and the aforementioned information types rated important to essential. Several of these elements address *friendly intent* directly - command/G2 guidance, command mission, and concept. Observation during all the exercises revealed that the synchronization of all subordinates' understanding of the commander's intent was the most critical of planning activities. If there was any lack of understanding of intent, it always adversely affected either mission planning or execution. Other elements clearly address *friendly location, activity, strength and capabilities*.

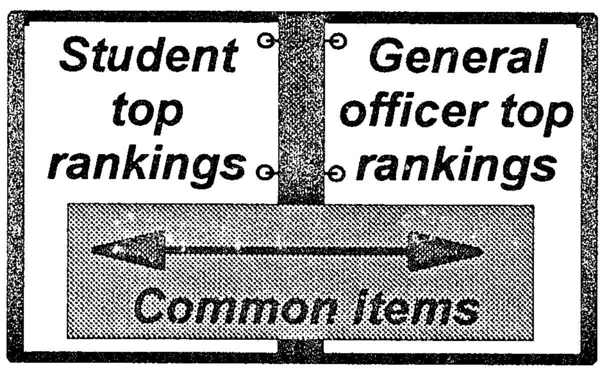
Enemy location is addressed by the element enemy situation/assessment. *Enemy intent* is addressed by enemy mission/objective. *Enemy activity* is addressed by the requirement for the intelligence summary and the enemy activity elements.

Critical terrain is notable as a highly ranked information element requirement. It is a fundamental mapping element, and mapping is fundamental to battle command. There is a strong relationship between critical terrain and area of operations, avenues of approach, and axis of advance.

Recommended Core Set of Information Elements for the RCP

- ***Common** top priority elements from BCE and CCIR surveys*

- Command/G2 guidance
- Enemy mission/objective
- Enemy situation/assessment
- Area of operations
- Command mission
- Enemy activity
- Battlefield geometry
- Concept (scheme of maneuver)
- Critical terrain
- Adjacent unit
- Intelligence summary
- Avenues of approach
- Assets available
- Axis of advance
- Friendly activity
- Enemy weapon systems
- Task organization
- Critical situation report



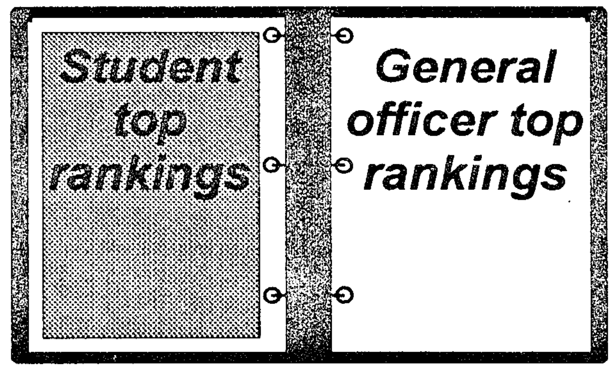
Recommended Core Set of Information Elements for the RCP
(continued)

The other elements in the top 26 of the BCE student ranking are shown. These did not rank in the top 25 of the general officer ranking, although most were ranked in the top half of their CCIR set. Note that physical features of the battlefield were important to the BCE students.

Recommended Core Set of Information Elements for the RCP (continued)

▸ ***Additional** elements from BCE student survey top 26*

- Terrain (avenues, concealment, mobility corridors)
- Order of battle
- Obstacles/barriers
- Weather data
- Aircraft allocations/priorities
- Battle losses (equipment)
- Situation report
- Assembly area location



Other Considerations for the RCP

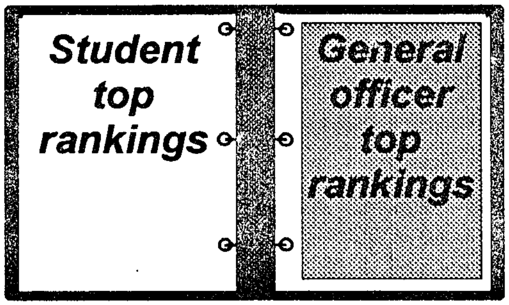
The elements which did not make the top 26 elements in the BCE ranking, but were in the top 25 elements of the CCIR ranking are shown at the top of this chart. The changing circumstances in the Army's role in nuclear operations between these surveys is evidenced by the last two elements which appear in this list. The importance of considering each of these groups of elements for the RCP is highly evident in this group. Nuclear-related elements can certainly become the highest priority in given situations, and the battle command support system must support them, mandating a tailorable component of the RCP and a force level data base which can be accessed by commanders and staffs. Also in this group is the element for electronic warfare (EW) and operations security (OPSEC) assessment. Information operations doctrine depends on commanders effectively integrating the areas of EW, OPSEC, deception, and psychological operations (PSYOP) to exploit information on the battlefield. The BCE students were not operating under this doctrine, which is presently being developed.

From the observations of the events previously mentioned, the study team found that the elements shown on the lower half of the chart also merit strong consideration for display capabilities supportive of the previously discussed information elements. The first capability is related to the visual display of the range component of systems, including sensors, and direct and indirect fire weapons. Automated range fan displays provide more complete information in an intuitive, graphical layout, enabling the commander to readily visualize the limits of his sensors and shooters. A three dimensional (3D) capability to the range fan displays would assist in control and deconfliction of airspace.

The second capability is related to the dynamic display of the location of entities. These entities include both friendly and enemy units but may also include, in a tailorable mode, individual systems, on the ground and in the air. One of the needs most cited by the BCE students in the various exercises was for dynamic display or tracking to support trend analysis, which they attempted with discrete data as best they could in each exercise.

Other Considerations for the RCP

- ***Additional** elements from CCIR general officer survey top 25*



  - Enemy aircraft
  - Friendly unit information
  - Assessment (EW & OPSEC)
  - Command-controlled items
  - Target criteria
  - Radiation dose status
  - Release policy (nuclear)

- ***Additional** elements from observation*
  - Range fans
    - Sensors
    - Direct fire systems
    - Indirect fire systems
  - Dynamic location
    - Friendly & enemy
    - Units & systems
    - Ground & air

✓ ***Diversity below the top ranking elements clearly demonstrates a requirement for a tailorable component of the RCP***

Conclusions

The study team concluded that the hypotheses were supported during the Battle Command AWEs.

First, the appropriateness of CGSC students for this work, especially students in the BCE, was observed, supported statistically, and documented. The data supporting this finding also reflect the fact that our Army educational system is focused and integrated, and that our mid- and high-level leadership is synchronized in the approach to battle command and Army tactical decisionmaking.

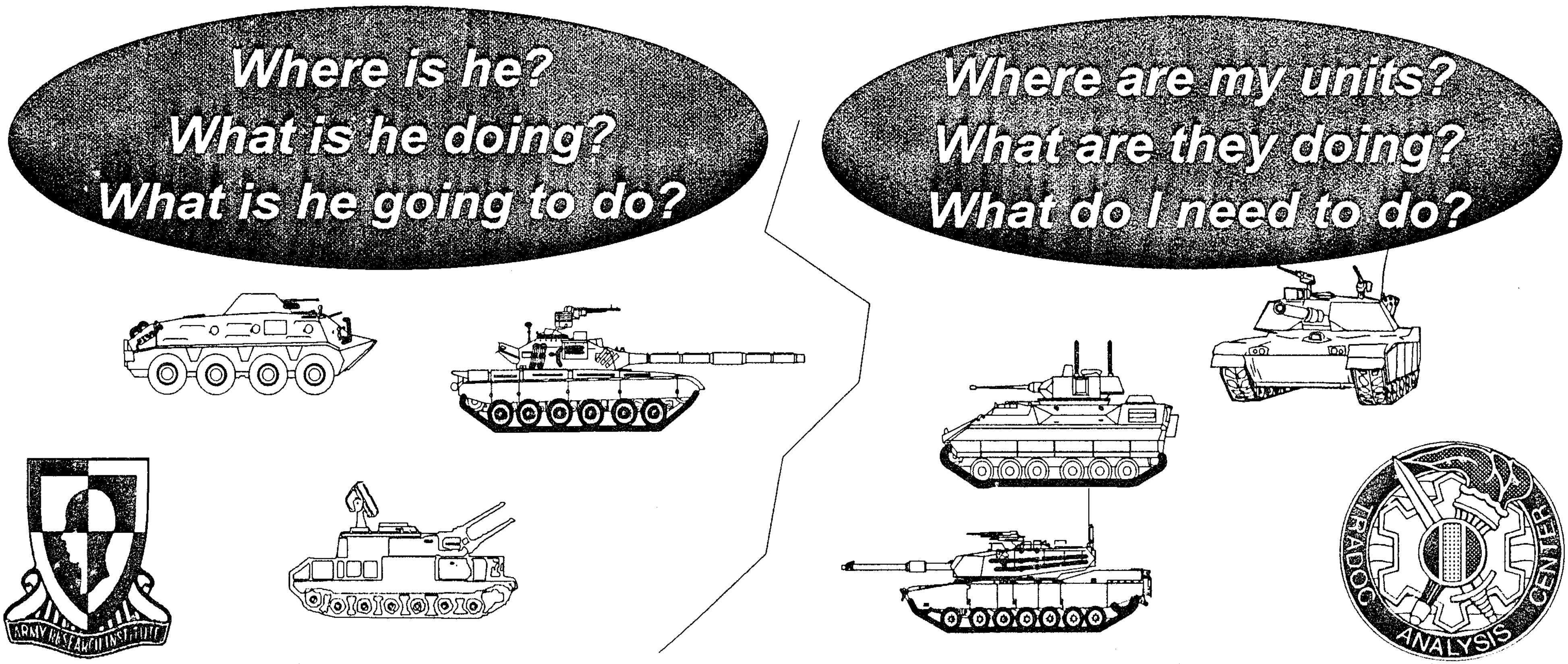
Second, the BCE student and general officer rankings of information elements comprising a set of CCIR were statistically identical, and a core, stable set of information elements was validated.

Finally, the AWEs confirmed that basic information requirements are simple elements which continue to tell the commander about enemy and friendly location, activity and intent. This idea can be supported by the entire body of historical evidence, which shows that the satisfaction of a certain set of information requirements sets the conditions for battle success.

This is not to say that situational awareness (of which these few elements are the essence) determines battle outcomes, but that it is a force multiplier which enhances the commander's chance of success with any given level of resources and mission requirements.

Conclusions

- CGSC students are appropriate to use to develop the RCP
- Army has an adequate core set of RCP information elements
- Most critical information elements continue to be:



Recommendations

The following recommendations are based on the study team's observations and analysis of the RCP issue.

The major recommendation is to use the highly-ranked information elements identified by the BCE students as the core of the division commander's RCP. The requirement for these elements to support battle command is essentially inflexible. This recommendation has two ancillary recommendations. First, the elements ranked in the top 25 of the prior CCIR study which were not common to both sets should always be considered for inclusion. This group of information elements could be used more flexibly to build the RCP in various situations. As an example, nuclear-related elements may not be needed in the Latin American theater, but may be part of the 2nd Infantry Division Commander's RCP in Korea (radiation dose status will probably elevate in importance in conflict regions where reactors are present). Second, a recurring need for several additional elements (or information display capabilities) which support the core RCP was observed. These are range fan and dynamic display capabilities.

The second major recommendation is to continue to modify and enhance the set of information elements over time, but do not re-do the work. The core elements the set must contain have been validated. Many important issues remain. The tailorability of the RCP is a concept which must be stressed, along with the fact that there is a timeless, core set of elements which is germane to the full range of military operations. Tailorability assumes the existence of a force level data base from which a commander can retrieve information. The display of the RCP must be addressed. These issues, and others, need more emphasis now than the fine-tuning of RCP elements.

Recommendations

- ✓ ***Use the BCE CCIR as a set of core elements of the division RCP***

Consider high ranked elements of prior CCIR study

Develop range fan and dynamic location capabilities

- ✓ ***Modify and enhance the set over time - do not start from scratch***

Recognize and design to accommodate a tailorable component of the RCP (situational effects on information requirements)

Develop comprehensive force level data bases

Battle Command Support System

This section reports on investigations of potential components of the Battle Command Support System (BCSS), according to the outline shown here.

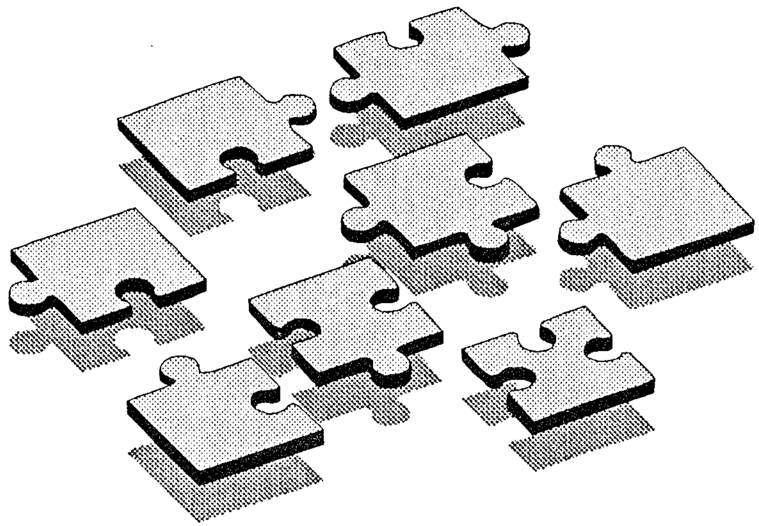
Battle Command Support System

- *Focus*
- *Hypotheses*
- *Methodology*
- *Questionnaire Results*
- *Video Teleconferencing*
- *Electronic Messaging*
- *Situational Awareness*
- *Other Automated Tools*
- *Staff and Process Elements*
- *Conclusions*

Focus

The BCSS is not a specific piece of hardware, but a system of components which provide the RCP to the commander. It includes staff, organization, staff processes, CP design, and information technologies, although the most visible and measurable elements during the Battle Command AWEs were the information technologies. While BCBL was tasked with developing a prototype BCSS capability, analytic issues focused on assessing the potential utility of information technologies and observing possibilities for changes in staff and staff processes.

Focus



BCBL Objective

Develop a prototype BCSS capability for a division commander

Analysis Issues

- What is the potential utility of selected information technologies to improve decisionmaking and combat operations?
- What changes may be useful in staff and staff processes?

Hypotheses

BCBL postulated that four basic capabilities should comprise the core capabilities of the BCSS information technologies. The four information capabilities included video teleconferencing (VTC), electronic messaging (e-mail), situational awareness, and automated operational status tools. Surrogates, or prototype information systems, were used to represent these capabilities.

VTC capability was provided through a commercially available video package connecting each MSF unit to a simulated VTC via personal computers (PCs). The capability was always available in a "push-to-talk" mode, and the students' switching requests, specifying which stations (up to four at a time) should be visible on screen were handled through a central station monitored by BCBL.

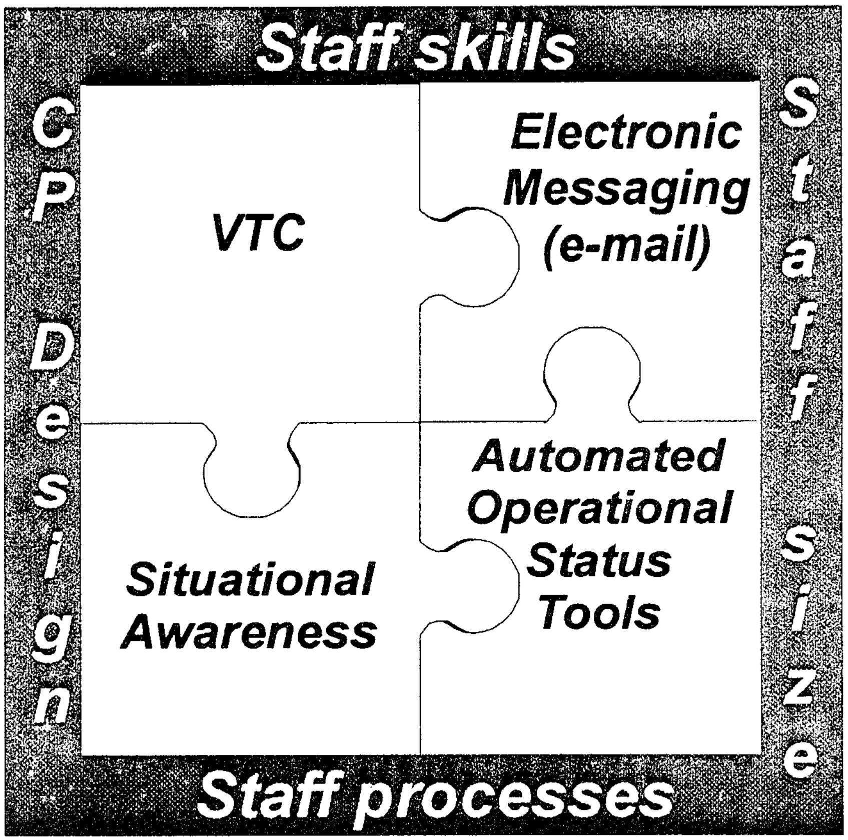
E-Note, a commercially available, PC-based electronic mail system, was used as a surrogate for the electronic messaging capability.

Several prototypes for a situational awareness capability were used throughout the AWEs. Situational awareness is comprised of but not limited to maps, graphics, overlays, OPFOR locations, and friendly force locations. The principal surrogates for providing this capability included the Space-Enhanced Command and Control (SPECC) system and the Battle Command Planning System (BCPS) based on a commercially available mapping software package (MapInfo). SPECC, developed through ARSPACE, was operated by skilled contractors, while BCPS-MapInfo was used on PCs by student warfighters. Additionally, the Commander's Visualization Research Tool (CoVRT) was introduced in the April experiment. Other related tools in this area included 3D terrain fly-through visualization tools (Mission Planning Rehearsal System (MPRS) and Flying Carpet), terrain analysis capabilities (Mission, Enemy, Terrain, Troops, and Time available (METT-T) system) and satellite image processing capabilities for map production (Multi-Spectral Imagery (MSI)).

The Battle Command Decision Support System (BCDSS) provided a semi-automated status tool. Other automated tools used throughout the AWEs included administrative applications, such as word processing, spreadsheets, and data base management systems, and predictive tools, including COA evaluators (CAMEX and Warfighting Simulation Proof-of-Principle Demonstrator (WARSIM POP-D)) and a weather effects analysis tool (Integrated Weather Effects Decision Aid (IWEDA)). These tools were not considered in the initial hypotheses but were evaluated to some degree in the AWEs.

Hypothesized changes in staff processes, staff size, staff skills, and CP design resulting from digitization of the battlefield are indicated here, but investigations were limited due to the use of a skeletal staff and the lack of realism in the setup of the CPs.

Hypotheses



- ✓ VTC, electronic messaging, situational awareness, and automated operational status tools are useful components of the BCSS

- ✓ Digitization will streamline staff processes, allowing reductions in staff size, permitting the use of multi-functional, multi-skilled staff officers, or suggesting efficiencies in CP design

Methodology

One means of assessing the information technologies was through student feedback, solicited through a series of short answer questionnaires, one for each decision aid or technology. Questionnaires provided a means to systematically address evaluation issues and allowed users to document their experiences with the technologies.

The questionnaires addressed a common set of issues chosen by BCBL, but each questionnaire was specifically tailored to the capabilities of the aid being addressed. The evaluation criteria included overall system usefulness, along with subordinate categories such as effect of the system on task performance, ease of use, and human factors aspects. Overall system utility results are included in this report, along with selected results in other categories.

Responses to the questionnaires were limited. Only fourteen of the 28 BCE students completed questionnaires. In addition, five government or contractor data collectors for the exercise completed more detailed versions of the questionnaires. These individuals were not proponents for the technology capabilities under consideration. Although the questionnaires were distributed early, the due date was set at the end of Prairie Warrior, to provide respondents an opportunity to assess the tools after an interactive BCTP warfighter-like exercise. Had the response date been set earlier, more participants may have focused on providing a thoughtful assessment.

A second method of assessing technologies and staff processes was through general observations of students during warfights, seminars, and AARs. The AWEs, though termed experiments, were neither rigorously designed nor controlled, so these observations must necessarily be considered only as insights. Further, the highlights regarding staff processes, size, and CP design were drawn from opportune observations of situations which suggested potential future changes, rather than a structured experimental design. The skeletal MSF staff and artificial environment of the exercise did not support development of robust conclusions about these issues.

Methodology

- ***Technology questionnaires***
  - 14 BCE students, 5 data collectors
  - Assessed overall system usefulness
    - Additional subordinate categories, including effect on performance, human factors, and user friendliness

Results limited by small number of respondents

- ***General observations of warfighting exercises, student seminars, AARs***
  - Observed student experiences with technologies

Insights regarding staff processes, CP design, staff size limited by context of exercise

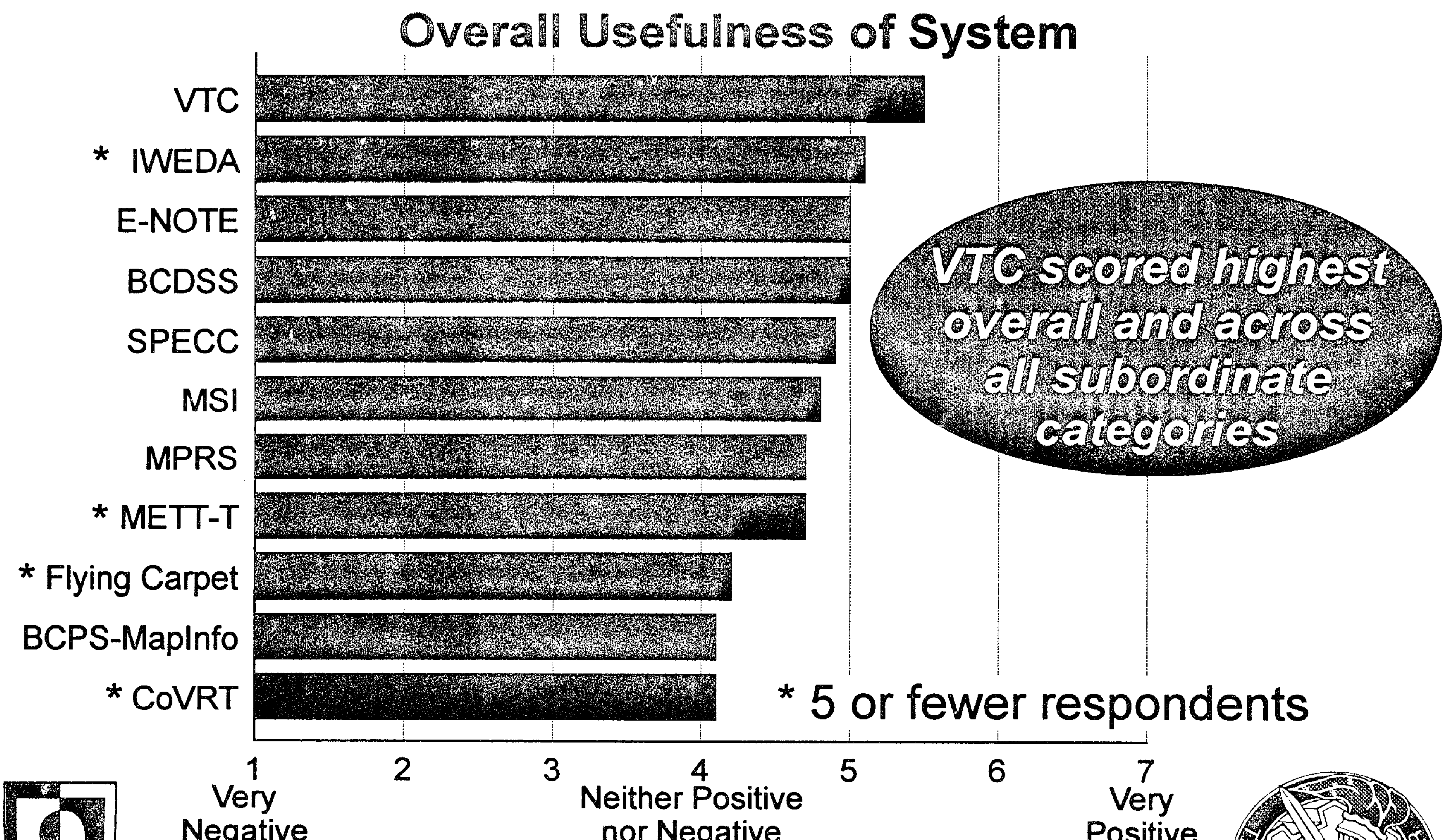
Questionnaire Results

Combined results of student and observer ratings of information technologies are provided here, for overall system utility. As discussed, questionnaires were returned by 19 individuals (14 students and 5 data collectors). Some of the systems were rated by 5 or fewer respondents, as noted, so the ratings must be taken in that context.

VTC was the highest rated system among students and observers. In addition to the overall system utility category, it was rated highest in all other categories, including flexibility, ease of use, improving task performance, and human factors aspects. IWEDA, a weather effects analysis tool, was also rated positively, although by a small number of individuals. This result was based on IWEDA's potential capabilities, since the simulation environment did not showcase the dynamic value of the decision aid. At the lower end of the ratings, CoVRT was only introduced in the April experiment, and only during the COA development process. The system provided sensor data to the commander in both processed and unprocessed formats. Most students, including intelligence officers, were unable to interpret sensor images, such as moving target indicators, provided by CoVRT. This experience, along with limited exposure to the tool, probably contributed to the small number of evaluations and neutral results. BCPS-MapInfo, on the other hand, was widely used throughout the MSF, and received ratings similar to CoVRT. Since it was the only computer software actually operated by the MSF staff, they were more familiar with its strengths <u>and</u> its shortfalls. As an off-the-shelf application, its flexibility and user friendliness were rated better than most systems, but technical quality and fit with organization and user requirements were not as high.

Additional ratings and observations are discussed in the following charts, under the capabilities of VTC, electronic messaging, situational awareness, and other automated tools.

Questionnaire Results



Neutral to positive results for all systems, but small number of respondents

VTC

Based upon student and observer ratings, and on AWE observations, this communications medium facilitates information exchange and the performance of all command and staff functions within the battle command realm of responsibility. During the AWEs, the open VTC network was used by the BCE students to perform staff updates, have open discussions of plan alternatives, conduct rehearsals of plans, develop and resolve issues as a result of plan rehearsals or reviews, support the COA development process and complete many of the organization's mission execution tasks. Problems were rapidly resolved in these face-to-face meetings. The success of the MSF deep strike operation in Prairie Warrior was attributed by observers to a very effective rehearsal facilitated by VTC. The strike, which integrated Air Force, Army aviation, artillery, and intelligence assets, resulted in the destruction of twelve battalions of enemy artillery, with the loss of a single Kiowa helicopter. For an experienced, cohesive division staff, this represents a very complex operation; for an ad hoc student staff like the MSF, the result was remarkable.

VTC also fostered a common understanding of the commander's intent, reaching a wider audience than would normally be addressable simultaneously. The ability to listen to or participate in discussions between division, brigade, and battalion commanders may quickly clarify inconsistencies or misunderstandings.

Observations indicate that VTC may be more suited for use by a particular group such as commanders and operations staff for updates. As most people prefer to communicate in a manner that is most familiar to them, most people would prefer face-to-face communication and this preference would result in network overload. In the near term, communications network limitations may also limit the distribution of VTC nodes. An open VTC network may lend itself to constant interruption of staff functions to answer the call to the VTC. However, one convenient capability offered by VTC on PCs was that no special rooms and bulky video equipment were needed to support the operation. Although there are limitations for multi-participant conferences, the ability to perform multiple tasks through a PC can greatly reduce equipment investments to support this capability.

Students highlighted the need for improved image transfer capability over VTC, such as a direct link from a computer rather than a photographic image.

VTC

- ***Ratings:*** Highest in all categories; very flexible, enhances quality of staff process
- ***Observed strengths:***
  - Information exchange and principal command and staff functions
  - More consistent understanding of commander's intent
  - May be best suited for updates for commanders and staff
  - PC implementation precludes need for large rooms and video equipment

Convenient virtual collocation

- ***Improvements:*** Direct feed of computer graphics rather than a photograph

✓ ***Great potential for synchronizing tactical operations and developing shared understanding of the battlefield***

Electronic Messaging

This communications tool was the foundation for exchange and dissemination of information in the MSF, and was highly rated for improving task performance and the staff process. It has high potential value for distributed communications. It provided the widest, most reliable, and assured method of communications for the MSF. It was used for real time bottom-up reporting, top-down decision flow, and lateral information exchange. Electronic messaging provided a record copy of all transmissions and can support the staff journal and continuous operations (CONOPS) requirements in greater detail and accuracy, possibly with fewer resources.

Students identified improvements to the prototype system used during the Battle Command AWEs, mostly in areas of human factors and user friendliness. Notes continually popped up on screen, interrupting ongoing work; although the off-the-shelf software did provide the option to control this interruption, students were not fully familiar with all the features of the tool. Students also wanted to establish priorities for messages, and work with user-friendly icons. The development and use of SOPs will become even more critical to efficient and effective battle command operations with this capability. A key to the utility of the capability is the degree of integration with other capabilities. The system must permit transmission of prepared text (plans and orders), graphics (maps and overlays), database and spreadsheet data and changes (decision support systems input and output), as well as text messages (spot reports, intelligence reports). Another enhancement would allow translation of information through parsing software from a message or text form directly into graphics locations. This capability could greatly speed up the posting of unit locations, areas of interest or target locations.

Electronic Messaging

- ***Ratings:*** High potential to improve task performance and enhance staff process, but prototype not user-friendly
- ***Observed strengths:***
  - Rapid information exchange and dissemination
  - Alternative means of real time reporting
  - Supports staff journal and report requirements
- ***Improvements:***
  - More sophisticated features
  - Establish protocols
  - Integrate with other capabilities, allowing text to graphics parsing (i.e., text coordinates to graphic map location) and transmission of text and graphics attachments

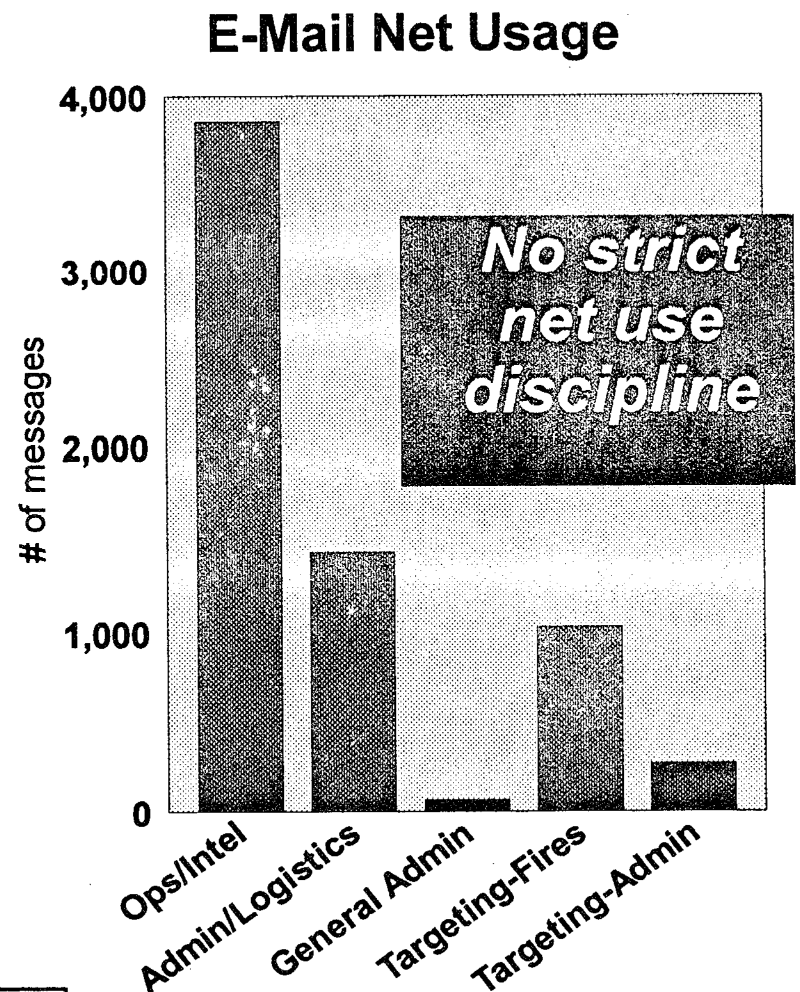
High potential for distributed communications

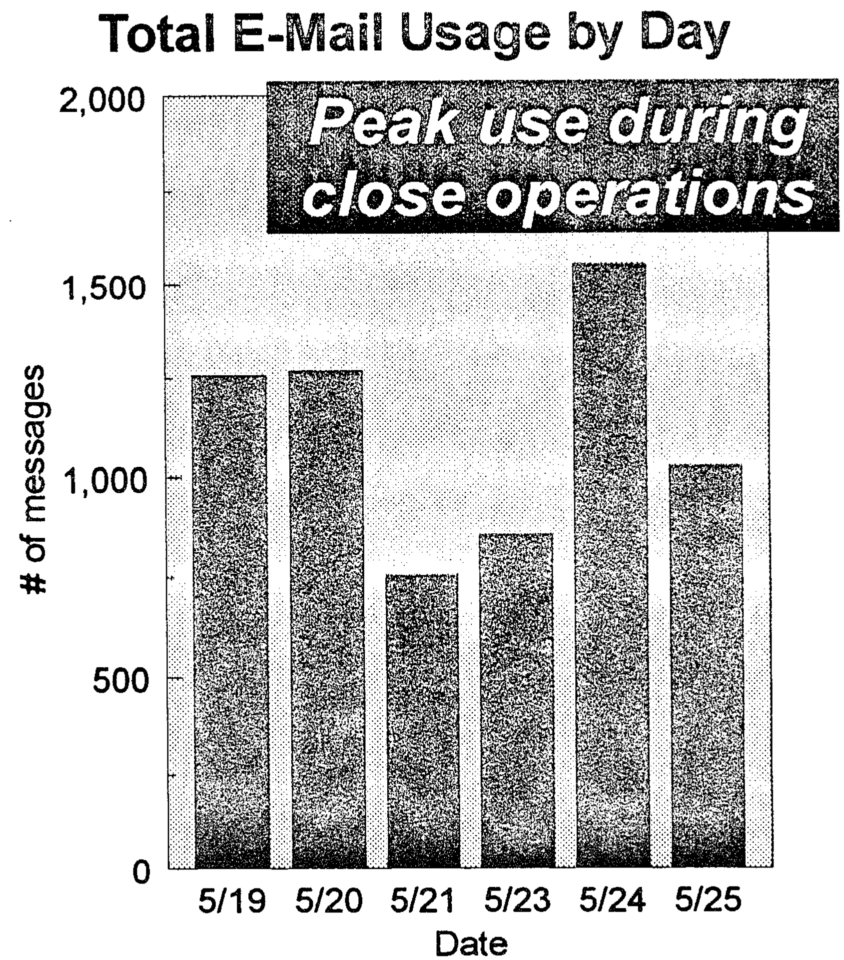
Electronic Messaging - Prairie Warrior Usage

The MSF staff used e-mail to represent several communication networks for staff interactions during Prairie Warrior. Different nets were represented by different colors of E-Notes as they were displayed at the staff workstations: red for Operations/Intelligence, blue for Administrative/Logistics, and yellow for General Administrative. During the course of the exercise other nets were added: green for Fire Support-Targeting, and gray for Fire Support-Administrative. Analysis of the E-Notes reinforced the need for the development and enforcement of SOPs: messages with similar content were transmitted over different nets, illustrating little discipline in the net usage standards.

As students discovered, e-mail can easily accumulate without effect -- as an example, during the last two days of the Prairie Warrior exercise, the severely understaffed MSF Analysis and Control Element (ACE) left 230 notes unread in their electronic mailbox. The volume of e-mail traffic hit a peak on 24 May 94 as the MSF ground forces were engaged in close operations.

Electronic Messaging - Prairie Warrior Usage





Situational Awareness

Digital mapping capabilities were highly rated as contributors to improving the situation assessment process. These capabilities support the display of several recommended elements of the RCP, including terrain (critical and general), avenues of approach, axes of advance, battlefield geometry, obstacles, and barriers. SPECC and CoVRT were rated high for product quality, and SPECC provided a good fit with the needs of the organization, but both were lower in flexibility and user-friendliness; BCPS-MapInfo was viewed as more flexible, but not as high in quality. Likewise, the terrain visualization tools were generally rated high in quality, but required skilled technicians as operators and were not as flexible as respondents demanded.

Probably more important than the ratings of the prototypes were the observations of the promise of the capabilities. In the Prairie Warrior exercise, surrounded by digital displays of friendly and enemy situation at every turn, the MSF Commander reported that he could absorb the relevant common picture wherever he was -- in his words, "I could connect the dots". Digital mapping capabilities can incorporate military and civilian geographical and space-based data. This means that the military may no longer be tied strictly to Defense Mapping Agency (DMA) map data, their form and format, their capabilities to produce what is needed, the time delays and lead times required for acquiring data, and their limitations of areas of coverage or constraints on maintenance of accurate data. Digital mapping can open a window into a multitude of commercially available mapping data resources such as Landsat and SPOT data that can provide multi-spectral digital imaging data, enhancing terrain analysis capabilities and providing for the development of 3D terrain views. For a force projection Army this capability will be crucial as it may provide the only capability for basic development, rapid update or revision to the terrain picture to accommodate quick response times anticipated for future operations. In some areas of the world maps may not even exist and this will be the only method of preparing something that will be useful in time. In other areas the maps that do exist are 20 or more years old and do not reflect manmade or natural changes to the terrain.

When digital mapping is integrated with other capabilities such as COA analysis tools, it provides the basis for better integration of time and space in planning. Digital mapping facilitates rapid terrain analysis and visualization; instead of taking hours or days, operators using terrain analysis tools such as MSI and MPRS were able to provide assessments to the MSF staff in hours. Some separate queries may even be done in minutes or seconds. It also provides the opportunity for the first time to integrate and analyze the impact of environmental and weather effects on planned operations in a quick and effective manner. Digital mapping capabilities also allow variable displays of the same data without associated errors in manual transfers between map scales; this common error was committed by students in the January baseline experiment, where 8 kilometers separating the MSF sector from an adjacent division sector was "lost" during a scale transformation. Digital mapping can reduce the time and resources needed to store, update, and transport the thousands of maps required for the expanded battlespace divisions and corps can influence these days. Instead that information can be stored on laser compact disks (CDs) or other high density storage medium, or digitally transmitted anywhere in the world.

Situational Awareness

- ***Ratings of digital mapping tools*** (SPECC, BCPS-MapInfo, CoVRT): High potential to improve situation assessment, but mixed reactions to prototypes in quality, flexibility, and user friendliness
- ***Ratings of terrain visualization tools*** (MPRS, Flying Carpet, MSI, METT-T): High quality products, but lower flexibility, user friendliness, and human factors

"... I could connect the dots ..."
MSF Commander to CSA during Prairie Warrior 94

- ***Observed strengths:***
  - Basis for shared RCP
  - Integrates military & civilian geographical & space data
  - Means to integrate time and space, with COA tools
  - Rapid terrain analysis and variable display
  - More efficient storage media and transmission means

✓ ***Critical capability for information-age Army; prototypes in various stages of development***

Situational Awareness (continued)

Students identified many enhancements for the digital mapping and terrain visualization prototypes used in the AWEs. None of the systems provided a satisfactory level of responsiveness for updates and displays. Even with current zoom in and out capabilities on many mapping programs, going back and forth takes a lot of computing time and power, and can be cumbersome to the user. It is also easy for users to miss key details and fail to comprehend the whole picture. Most of the systems were operated by skilled technicians, due to lack of a user-friendly interface. The lack of adequate linkages to appropriate data bases meant that information had to be manually input in many cases. Objective mapping capabilities must be linked to force level data bases to quickly access friendly and enemy location.

Programs must be flexible enough to adapt to Army applications. The prototypes initially offered users the kinds of graphics symbols found in presentation software -- boxes, lines, circles and ellipses, polygons, and so on. These provided "work-around" solutions, but a full range of standard military symbols -- to depict units, obstacles, phase lines, boundaries, objectives, axis of advance, assembly areas -- should be provided with a digital mapping capability. Additionally, the terrain visualization tools did not provide the capability to overlay operational graphics on the screen; many of the students, general officers, and other visitors suggested the addition of this feature.

Students demanded a high degree of resolution for digital maps. Even when this was available, some planning and other functional tasks were difficult to execute when using a small monitor. The view is either limited to a very small area or the scale must be reduced to the point that the details are lost. Therefore, there is still a real need for large screen displays that will allow small groups of people to gather around and conduct planning using an appropriate level of area coverage and scale. These images could be projected from a digital source. Finally, when planning is conducted from remote locations, it would be useful to have an interactive graphics capability for highlighting concepts on a digital map. The MSF simulated this capability by projecting a digital image over VTC, but the map resolution suffered in the process.

As a parting thought, observers believe some consideration should be given to the idea of a holographic sand table to support terrain visualization and COA evaluation in the future. Given the current state of the art in terrain visualization tools, this capability is not as distant as it may seem. Use of a sand table is ancient technology but has been a very effective tool for ages. The ability to generate this type of image in a holographic form could be invaluable to the field units and staffs.

Situational Awareness (continued)

- ***Improvements in digital mapping and terrain visualization prototypes:***
  - Slow and cumbersome, most not user-friendly
  - Automated interface to force level data base
  - Flexibility - operational symbols toolbar, and operational graphics overlays for terrain visualization tools
  - Clarity of image at least as good as paper maps
  - Large screen displays still required for some levels of comprehension and functional execution
  - Highlighting capability ("John Madden light pen") with shared view from remote locations
  - Far term possibilities - holographic sand table?

Foundation for situational awareness - but not universally accepted by students in current state

Other Automated Tools - Operational Status and Administrative

Other automated tools used in the BCE applied to staff operations, administration, and specific predictive functions. Of these, operational status tools were hypothesized as a useful component of the BCSS.

BCDSS was used as a prototype for an operational status reporting system. Although it lacked a good mechanism for updating all staff elements, students rated the potential value of the capability high, and senior mentors reinforced that value through their insistence that staff members provide a quick visual display of the status of critical unit resources. It provided an easily understood display of available assets and battle losses, two recommended elements of the RCP. An objective capability should access a data base linked to self-reporting capabilities of combat systems to update status information.

Not specifically addressed in the BCSS hypotheses or AWEs but obviously needed was an integrated suite of office automation products. This provides the capability to prepare, package, and disseminate required information, such as operations orders or a synchronization matrix, with a consistent single software package. While electronic messaging was addressed separately, most integrated office packages include a mail capability that works in concert with the other packages. User-friendliness of software is critical. For these automated tools to be effective they must operate within a network environment that is accessible to all. Commercial off-the-shelf (COTS) software can provide a low cost, high quality solution to this requirement, as the development and upgrade costs are shared among millions of customers beyond Army users.

With the proliferation of computers, protection of information and information systems cannot be casually addressed. A virus was inadvertently introduced on the MSF network by a student warfighter. The BCBL support team spent several hours cleaning up machines, but the experience carried through the exercise in other ways, as students who experienced problems with PCs added "virus" to their list of possible causes.

Other Automated Tools - Operational Status and Administrative

- ***Ratings of operational status tools*** (BCDSS): High potential in many areas - flexibility, human factors, user-friendliness, improving task performance and staff process
- ***Observed strengths***: Senior mentors reinforced need for aggregated display
- ***Improvements:*** Update process cumbersome

- ***Ratings of administrative tools*** (office suite): Not requested
- ***Observations:*** Students used available programs and a few brought in software/hardware ***(and a virus)***
- ***Improvements:*** Must be compatible with operating environment of other information technologies to enhance portability of training; must be user-friendly; must be protected

COTS software can fulfill many basic requirements

Other Automated Tools - Predictive

Predictive tools in this class included COA analysis tools and weather prediction software.

Several experiences with COA evaluation tools were observed, though students were not asked to rate these tools. A subset of the BCE students used the CAMEX model during the March experiment to evaluate and refine courses of action. The process was useful in synchronizing the operation and in assuring that students looked across all assets in developing their plans. However, because students were not able to operate the tool due to lack of training, it was critical that they understood the assumptions used by analysts in implementing the COAs in the model. Presentation of the COAs back to the full student group reinforced this requirement. BCE students requested further use of the tool to support Prairie Warrior preparations in the Advanced Tactics Elective and during the Prairie Warrior exercise. A new prototype, WARSIM POP-D, was also provided and used during Prairie Warrior. The capabilities offered by these tools have high potential value in supporting the planning process. The detail provided by these technologies has typically been confined to analytic agencies, and validity of results must be maintained as user-friendliness is enhanced. Linkage to digital mapping technologies would also improve the utility of these tools, to allow planners to move forward from a current assessment of the situation.

Weather prediction software was demonstrated during the BCE and judged by a small number of respondents to have high potential for improving planning tasks, though usage was not high, probably because of the nature of the simulation environment and limited impact of weather in the exercise.

Other Automated Tools - Predictive

- ***Ratings of COA analysis tools*** (CAMEX, WARSIM POP-D): Not requested
- ***Observed strengths:*** Valuable for synchronizing tactical operations, enhancing the rehearsal process
- ***Improvements:***
  - Ensure warfighters understand assumptions/limitations
  - Enhance user friendliness
  - Link to digital mapping capability

- ***Ratings of weather effects tools*** (IWEDA): High potential value for planning and rehearsals, improving quality of staff process
- ***Observations:*** Little use of prototype in simulation environment
- ***Improvements:*** Flexibility, user friendliness, human factors

High potential area - but COA tools were the least mature prototypes

Staff and Process Elements

The 28 students in the January and March BCE experiments represented a division commander and staff, and skeletal staffs at subordinate units. This environment necessarily aggregated many division staff functions and ignored others. The staff was augmented by about 120 students for Prairie Warrior, but student skills and assignments were mismatched in some cases, and augmentees were not familiar with the procedures and technologies of the MSF. Thus, specific conclusions regarding staff size, processes, skills, and setup are inappropriate, although a few general observations can be made. Additionally, the introduction of the MSF with an incomplete concept and unfamiliar systems complicated the exercise and obscured other potential insights.

Comparisons between January and March exercises did reveal a tremendous difference in time devoted to posting unit locations on maps. In January, many students were literally consumed by the process. In March, virtually no one was devoted to the task because the locations were automatically posted on digital maps. It still takes considerable time to identify and track units and verify locations, but improvements in efficiency and accuracy of the task seem certain.

During the AWEs, a hypothesis was posed that multi-functional, multi-skilled staff officers might be required in the future. While not tested, observers noted that aviators and artillery staff officers repeatedly had to modify proposed COAs because maneuver officers developed inappropriate roles for these arms. Supporting this observation is the requirement in the CGSC Tactical Commander's Development Course for maneuver commanders to spend additional time (over combat support force commanders) learning to integrate all facets of the combined arms team. Specialization requirements in the intelligence area were also supported. In one experiment, the MSF G2 was asked to interpret moving target indicator data and other imagery for the MSF Commander, because the Commander did not understand the information displayed. The G2 was not a qualified imagery analyst, and was unable to provide any insights regarding the sensor images. Likewise, during Prairie Warrior, the ACE chief was an intelligence officer with an acquisition specialty; he had transferred to the military intelligence branch after 11 years in air defense artillery. With this background, he was somewhat overwhelmed by the requirements of his position during the exercise.

An alternative division CP design with forward and rearward cells was used in the experiments. No conclusions can be made about the effectiveness of the concept because of gaps in functions performed by the division staff.

Examinations of staff processes were likewise limited, but there were interesting observations of the challenges of partial modernization of information technologies with the MSF assigned to a non-digitized corps. Relations were initially strained between the Corps and MSF Commanders, with the MSF situational awareness ahead of the corps by five hours or more. On one occasion, the Corps Commander simply could not accept or believe the reported positions of the MSF. Fratricide implications of the modernization challenge are striking.

Staff and Process Elements

- Laboratory environment and emerging concepts limit realism
- General observations
  - ***Staff size:*** digital mapping capability with automated unit location displays in March experiment greatly reduced map posting requirements
  - ***Staff skills:*** possibility of multi-skilled, multi-functional staff officers not tested, but requirement for specialists, particularly in intelligence, aviation and fire support seen in mission planning tasks and interpretation of sensor data
  - ***CP design:*** division forward and rearward concept not adequately tested
  - ***Staff processes:*** special challenges with high-low mix of information technologies

Experimental design gaps must be overcome for detailed analyses of staff and process issues

Conclusions

Conclusions regarding the useful components of a BCSS are shown here. One measure of usefulness of a technology is the extent to which it is used. Basic communication or display systems, such as VTC, E-Note, BCPS-MapInfo, and BCDSS, experienced high use among the BCE students, implying a need for and acceptance of products they can deliver. The capabilities provided by these prototypes span the hypothesized components of the BCSS. Students rated the potential of all these capabilities very high in developing situational awareness, creating shared understanding of the battlefield, providing distributed communications, and synchronizing tactical operations.

Additionally, an integrated office automation package to support administrative tasks, and predictive tools to support planning, should be considered for inclusion in the BCSS based on observations of the AWEs.

By no means does this imply wide-scale acceptance of the current capabilities of these products as objective solutions. The system which was used the most also had some of the lowest scores in the evaluation categories, probably because students were more familiar with the system and likewise more familiar with its shortfalls. Faults in other systems may not have been so apparent. Nearly all the technologies require improvements in user friendliness, automated linkages to data sources, and commonality and standardization among key factors in the environment and interface. This requirement is even more important considering the pace of change of information technologies and the demand for computer literacy for future warfighters; portability of training from one system to another will be critical. Beyond commonality, tools must be integrated, or "connected", such that the products and data from one system can be sent to another in a usable format, for display, modification, or incorporation in the receiver's products.

As discussed, no conclusions regarding staff and process changes can be made without a better representation of all required staff functions.

Conclusions

Useful BCSS components

- Ratings and observations reinforced potential value of capabilities (VTC, electronic messaging, situational awareness, and operational status tools)
- Administrative and predictive tools also have potential to improve decisionmaking and performance
- Most tools not user friendly, and entry of current information should be automated
- Need for some degree of standardization/commonality among capabilities and information systems (icons, tools, operating environment)
- Need for systems and tools to be integrated

Changes in staff processes

No conclusion - further investigation required

Impact on the MSF Commander

This section reports on the effort to support BCBL in describing the effects of digitization on the MSF Commander during Prairie Warrior. The section is organized as shown.

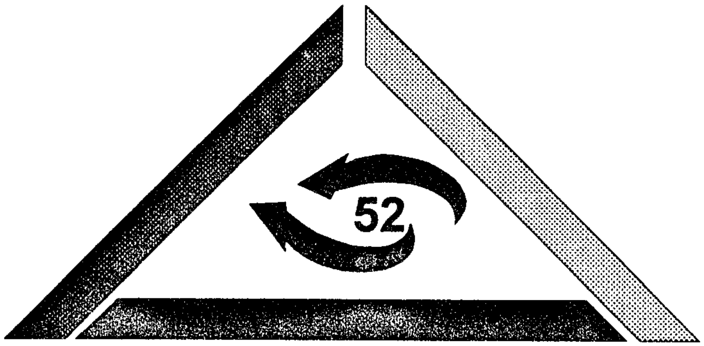
Impact on the MSF Commander

- ► *Focus*
- ► *Hypotheses*
- ► *Methodology*
- ► *Cognitive Styles*
- ► *Contrasts in Reasoning Style*
- ► *Example and Measures of Interpretive Reasoning*
- ► *Decision Cycle Comparisons*
- ► *MSF Commander's Use of Digitization*
- ► *Intuition and Digitization*
- ► *Conclusions*

Focus

Determining the impact of the RCP on the MSF Commander was the final BCBL objective addressed in the FY94 battle command experiments. Although three analysis issues were initially associated with this objective, this briefing addresses only the first issue shown here. Insights were drawn from observations of the MSF Commander and another student division commander during Prairie Warrior. ARI will publish a separate report on shared understandings, the second issue. With respect to the third issue, ARI did collect data regarding battle tempo during Prairie Warrior. In addition to the division commanders, data collectors observed other primary decisionmakers in each division. The intent was to determine the amount of time it took from realization of the need for a change in mission, task organization, boundary, or schedule to the issuance of an order including that change. The team hypothesized that digitization would result in the MSF having a more rapid battle tempo as defined by this measure. A combination of factors resulted in an inability to produce valid data for battle tempo. Chief among these was the problem with game time which made the orders publication time impossible to determine in most incidences. The team was also unable to obtain written orders for the MSF during the time observed. They did, however, obtain good decision cycle data on the commanders, which is reported in this briefing.

Focus



Mobile Strike Force

BCBL Objective

Report on the impact of the RCP on the MSF Commander during Prairie Warrior

Analysis Issues

✓ What are the effects of digitization enhancements on data use (interpretation, decisionmaking, cognitive process)?

To be addressed in separate ARI report

What are the effects of digitization on shared understandings of the battlefield?

Unable to address with valid data

What are the effects of digitization on battle tempo?

Hypotheses

The study team recognized that observations of just two student commanders would be limiting. They expected relevant individual differences to strongly influence the results, perhaps regardless of the experimental condition of digitization, if the differences were great enough. They viewed problem solving and reasoning styles as the most relevant individual differences in this situation. The team hypothesized that reasoning style could be measured sufficiently to determine real differences between the two commanders. It also followed that reasoning style should interact with effects of digitization intended to support the commander's decisionmaking, and these interactions were also the focus of observations of the MSF Commander.

The team also postulated that digitization would improve the situational awareness of the MSF Commander. Practical constraints of the exercise made it impossible to measure the commanders' situational awareness directly. To do so would require frequent and lengthy debriefings, taking the commanders out of the exercise. It was never contemplated that observers would be able to do that. Instead, they sought to infer situational awareness level from other measures related to the commanders' decision cycles and reasoning processes.

Finally, the higher the situational awareness as a result of digitization, the fewer questions the commander should have to ask of his superiors, staff, and subordinates. Likewise, the greater the situational awareness, the more comprehensive the commander's decisions should be, both in terms of the number of factors considered and the time horizons encompassed by the decisions.

Hypotheses

- The dominant reasoning style of the MSF Commander can be measured and will interact with digitization in ways to be determined
- Digitization will increase the situational awareness of the MSF Commander
- Increased situational awareness will result both in shorter decision cycles and increased breadth of decisions

Methodology

ARI identified several standardized tests that would yield a sufficient aggregate measure of reasoning style. These were administered several days before the Prairie Warrior exercise to the two CGSC student division commanders and were scored according to the test instructions.

During the exercise observations were made by following the commanders and recording their oral verbalizations plus information as to where, with whom and any special circumstances under which these verbalizations occurred. The observers followed the other student commander over the first two and a half days of Prairie Warrior, and the MSF Commander over the last two and a half days of the exercise, hoping to catch both commanders when their divisions were decisively engaged. From these recordings, decision cycles were identified and analyzed. In addition, short interviews with the commanders were conducted on a time available basis. Four interviews with the other commander were conducted, but only one with the MSF Commander, so they were not as useful as hoped.

The team developed a prototype method of categorizing the verbalizations as to the types of reasoning they represented. Some faults were found with this method and the results are not reported here. However, the detailed analysis involved in the application brought to light many differences between the two commanders. These differences were further investigated in follow-on analyses, centering around the general conclusion that the MSF commander was more "interpretive" in his reasoning than his counterpart. This hypothesis directed the search for more objective evidence and the generation of further hypotheses as to how it affected his use of digitization. Relevant information regarding the MSF Chief of Staff (C/S) was included in this process to illustrate differences in reasoning style.

Key limitations of this investigation are reiterated here. The remainder of this section provides cognitive styles definitions, examples, and measures relevant to the analysis, then discusses decision cycles, use of digitization, and the relationship between intuition and digitization.

Methodology

- ***Initial data elements:***

Cognitive style tests → **_MSF Commander_** / **_Other Commander_** ← *Observed interactions and verbalizations*

- ***Analysis:***
  - Determine self-reported differences in problem solving styles
  - Identify decision cycles and derive measures
  - Categorize verbalizations by reasoning type (prototype categorization method unsatisfactory but led to additional analysis of the verbalizations)
- ***Additional investigations:***
  - Characteristics of interpretive reasoners
  - Relevant observations of other staff members, notably MSF C/S

Limited number of subjects
Constrained availability for interviews
Prototype data collection procedures
Insights rather than conclusive evidence

TRADOC ANALYSIS CENTER

Cognitive Styles - Learning and Problem Solving

Cognitive style inventories provide indications of different ways people process information. They indicate how information is perceived, represented, and linked to other information, and how problems are solved. Cognitive skills are the abilities to consistently carry out tasks, while styles refer to how people tend to adopt similar strategies across tasks and settings.

Because of the complexities of human behavior and limitations in the quality of measurement, styles must be interpreted with caution. The particular styles that were examined for Prairie Warrior were exploratory; they were chosen because of their apparent link to expertise and complex problem solving.

The MSF Commander indicated a "diverger" learning and problem solving style. His style is to reflect, view a situation from many perspectives, and resolve complex relationships into a coherent picture. The drawback of this style may be delayed action due to deeper thinking.

The other student division commander indicated a "converger" learning and problem solving style. This style leads to dealing with specific, separate problems through practical application of knowledge and deduction. This style may lead to hasty action and addressing problems of lower importance.

Cognitive Styles - Learning and Problem Solving

MSF Commander: Diverger		***Other Commander: Converger***
Reflective, generates ideas		Practical application
Views many perspectives		Hypothetical-deductive reasoning
Organizes relationships into meaningful whole		Focused on specific problems
(Hindered by complex view?)		(May decide too quickly or on wrong problem?)
3 SD above average	← ***Need for cognition*** →	5 SD above average
Self in control	← ***Locus of control*** →	Self in control
Average	← ***Tolerance of ambiguity*** →	Average

SD = standard deviations

Cognitive Styles - Reasoning

Probably no individual is purely interpretive or generative in their reasoning and reasoning styles can change with the type of situation. But the person with a more interpretive style (as defined here) will appear to derive conclusions and reach decisions in the absence of external stimuli directing them. Related decisions often are produced in rapid succession and it is not uncommon for the individual to be unable to relate the procedure used in deriving them because most of the reasoning involved probably never reaches conscious awareness. One explanation of this is that the interpretive individual has an elaborate set of interrelated knowledge structures for their area of expertise; they use these structures to build mental models of the situation or course of action. The environment provides cues that recall some set of organized knowledge (called schema) that, in turn, recalls other linked knowledge structures. Thus a whole chain of reasoning can occur rapidly with minimal inputs from the environment. The more interpretive person puts greater reliance on these subject matter knowledge structures when faced with a problem in their area of expertise, and can build detailed mental models of a situation rapidly.

The more generative person may have detailed and compiled subject matter structures as well but is less disposed to depend upon them in drawing conclusions and building plans. Instead, they have more highly developed procedural knowledge structures (problem solving techniques) that they depend upon in making decisions.

As stated before, no one is purely one or the other. A more interpretive person can be very good at applying generative techniques, usually when preexisting schema do not seem to adequately cover the current situation. Knowledgeable people who are typically generative can be very good at interpretive decisionmaking under time pressure.

The spectrum here, while not intended as a precise scale, illustrates the finding that the MSF Commander was more interpretive in his reasoning style than the other student division commander. The MSF C/S was more of a generative reasoner than either of the student commanders. A classic example of the difference between the two styles can be seen in a recorded interaction between the MSF Commander and his C/S during Prairie Warrior.

Cognitive Styles - Reasoning

	INTERPRETIVE	GENERATIVE
► Source of Data	• More internal, less external	• More external, less internal
► Procedure	• No obvious structure	• Step-by-step
► Speed of Accomplishment	• Can be done very rapidly	• Cannot exceed the assimilation of information
► Type of Knowledge Constructs Used	• More subject matter, less procedural	• More procedural, less subject matter
► Level of Awareness	• Less conscious of reasoning processes	• More conscious of reasoning processes

INTERPRETIVE ——— ***GENERATIVE***

MSF Commander ***Other Commander*** ***MSF C/S***

Contrasts in Reasoning Style

It had just been determined that the enemy would probably attack with two divisions abreast instead of the one division in the first echelon, which was the basis of previous plans. The MSF Commander was beginning to formulate a plan for meeting this new threat.

The MSF C/S had established himself in previous exercises as a generative reasoner. In following his tendency to reason this way, he suggests a formal analysis to establish the timelines and schedule of events that need to occur to meet this threat.

The MSF Commander responds with a set of conclusions he had already reached in his mental wargaming based upon applying his own knowledge structures to the problem.

The C/S was a recognized tactician and probably could have conducted his own mental wargame comparable to the Commander's. The Commander knew and had practiced the formal decisionmaking procedures like the C/S. The difference, faced with the same tactical problem, is one of preferred reasoning styles.

That the MSF Commander was more of an interpretive reasoner can be further illustrated by another example from the Prairie Warrior observations.

Contrasts in Reasoning Style

***Commander:* "We will attack in zone: objective BOSTON."**

Generative - verbalize steps in planning the operation

Interpretive - visualize and describe the operation

***Chief of Staff:* "We need to figure the timing and where we want to be; how long it will take to refuel. We don't want to get caught where we don't want to be."**

***Commander:* "We should get eyes on the Governor's Vanguard in the next two hours. If we can support aviation strikes real early, we should start hitting him. As the cav moves up, his artillery can support it."**

Example of Interpretive Reasoning

This example occurred about the same time as the previous one so the setting is the same. The underlined texts represent the verbalizations of special interest here.

The MSF Commander is considering how he will counter the two division threat. His Aviation brigade is conducting a zone reconnaissance forward and has no significant enemy contact thus far. He concludes that he can gain a real terrain advantage if the reconnaissance continues to find his route of march clear. This leads to the opening conclusion shown here.

Note how, <u>without further input from outside sources</u>, he continues to detail his concept of the zone reconnaissance. As he is detailing the general concept, the thought comes to him that the enemy will be much more effective when daylight comes.

This thought appears to link with its effect on his zone reconnaissance and the guidance to his brigade commander to that effect follows at 1102. There then must be further reasoning on the negative effect of speed on the reconnaissance and that is added as a caution at 1104. So a progressive detailing of his mental model of zone reconnaissance occurs without apparent external influences -- a characteristic of interpretive reasoning.

Frequent examples of this occur throughout the 30 hours the MSF Commander was observed, but what about other indicators of interpretive reasoning? It might be anticipated that if less external data were required for the interpretive decisionmaker, he should request less information from others. Also, he should offer more spontaneous situation assessments (ones not requested by others) if he were generating conclusions within an internal chain of reasoning not necessarily linked to what was going on around him. Results of these investigations follow.

Example of Interpretive Reasoning

MSF Commander

241050 (to Aviation Brigade Commander):

"The further forward you can get, the better off we are."

Rapid advancement of complexity of plan and recognition of relevant factors without external influence

241053 (to Assistant Division Commander - Maneuver):

"Basically, we will lock horns with two divisions and a separate brigade. The more stuff we can get forward then, the better. I see the fight happening forward of BOSTON. We will have to do this sequentially with maximum combat power forward. We will not get the ACR [had been told this]. We need to get up there, get the LOCs open, and get the aviation forward. I can see the enemy releasing a lot of stuff at first light to mess us up."

241102 (to Aviation Brigade Commander):

".....When the sun comes up the recon will be degraded. So I want you to get as far forward as possible by daylight."

241104 (to Aviation Brigade Commander):

"...I don't want the recon to get overstretched, but we must exploit the darkness."

Measures of Interpretive Reasoning

There were differences between the two commanders' reasoning styles that have been discussed in regard to self-report data. Differences were also confirmed by a detailed analysis of their reasoning performed in an unsuccessful attempt to categorize their conclusions and decisions as to the reasoning types represented. From these it was concluded that the MSF Commander was at least more interpretive than the other commander. So it was anticipated that the differences projected between interpretive and generative preferences should appear between the two, although to a lesser degree than would have been anticipated had the comparison been between the MSF Commander and his C/S.

The findings do not support the predictions in terms of the number of questions asked and the staff taskings for information. The number of questions asked were almost identical when the two hour difference in the amount of time observed is considered (30 hours for the MSF Commander, 28 hours for the other commander). The MSF Commander exceeded the other commander in requests to his staff for additional information. During execution, however, the MSF Commander had a particular problem in getting the type of intelligence he wanted which generated many requests. Other explanations may be that the MSF Commander knew he could obtain in-depth information on demand. Alternatively, his contingency mission as the operational reserve may have dictated that he consider a much broader range of information than the other division commander.

There is strong support for the measure of the number of spontaneous situation assessments generated. The MSF Commander verbalized over three times as many of these as did his counterpart. Only situation assessments offered without external prompting were counted here to reduce the probability that they were generated on-the-spot and not as part of some unobserved chain of reasoning.

The unexpected finding of equal number of questions was investigated further. This was done for two reasons: first, to see if there were some underlying differences in the nature of the questions that might be more revealing, and secondly, because this issue has direct relevance to digitization. If digitization does not reduce the amount of reliance the commander must place upon his staff, then one of its anticipated benefits is in question. The findings of this extended investigation are depicted on the following set of pages.

Measures of Interpretive Reasoning

Unexpected higher number of questions and staff info taskings - several plausible explanations

	MSF Commander	*Other Commander*
Number of Questions Asked	111	100
Number of Staff Info Taskings	27	19
Number of Spontaneous Situation Assessments	131	40

Expected of interpretive reasoner

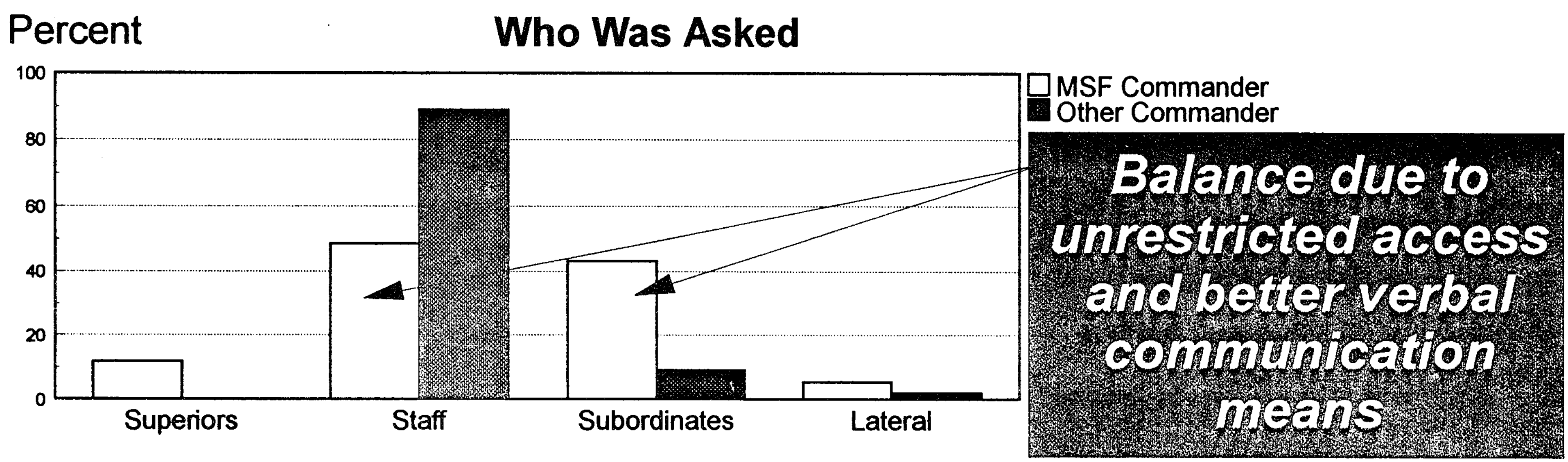
Measures of Interpretive Reasoning - Analysis of Questions Asked

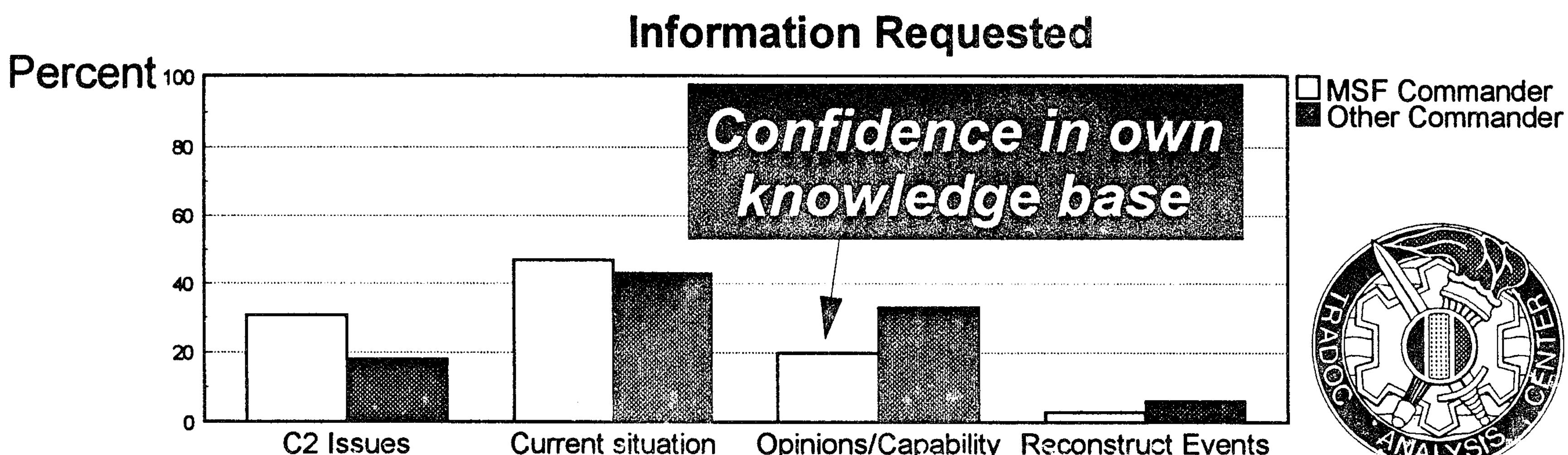
The first graph highlights the groups who were asked questions by the student commanders. The MSF Commander had ready access to his subordinate commanders. He could talk with them on the VTC and their command posts were in the same building. There were no restrictions on his visiting their CPs. He took full advantage of both means of communication. The other commander could not visit his subordinate CPs, and his means of verbal communication were not as good. Thus the differences in relative use of staff and subordinates as information sources is probably due in great measure to these two reasons. Although the other commander had several face-to-face visits with his Corps Commander, observers recorded no questions being asked by the other commander during these visits.

The second chart indicates the types of information requested by the commanders. Command and control (C2) issues included questions concerning orders, future plans, and the status of C2. The criticality of C2 for the MSF during this test generated some of the difference here, but the MSF Commander was also more actively involved in generating plans. The difference in "knowledge" type questions -- asking for opinions and system capabilities -- is a good indication of the relative confidence the MSF Commander had in his own knowledge base and his reliance upon it.

Approximately the same percent of their questions involved understanding the current situation, both friendly and enemy. An analysis of these questions did reveal that more of the MSF Commander's questions dealt with tracking specific aspects of preparation for and execution of his plans (54% versus 38%) while the other commander had more general "how goes it" questions. The MSF Commander also had a complex contingency mission which may have generated additional requirements. These possibilities may help explain why the MSF Commander asked as many questions, but the general findings here offer no support for digitization providing a greater situational awareness and reduced need for personal communications.

Measures of Interpretive Reasoning - Analysis of Questions Asked





Decision Cycle Comparisons

A "decision cycle" is a grouping of interactions concerning a particular event, mission, or tasking that has discrete start and end points and can be grouped more or less independent of other decision cycles. The MSF Commander had half again as many decision cycles as the other commander.

External initiation of cycles includes receipt of orders, requests from subordinates, and "suggestions" from staff and mentors. Internal initiation occurs when the individual realizes the need for a decision on his own. The two commanders had nearly the same proportion of internal-external initiation.

The decision cycles of the MSF Commander tended to last longer despite the fact that he was not observed until the last half of the exercise. Eight of his 18 cycles lasted longer than 12 hours compared to 3 of 12 for his counterpart. Without considering the decision cycle that includes the MSF Commander's final execution, in which he made 70 separate decisions, the two are fairly well balanced regarding the average number of decisions per cycle.

Time horizon is the difference between the current time and the time of the most future event involved in the cycle; it is typically calculated from the start of the cycle. The MSF Commander's time horizons were usually longer despite the fact that he was observed toward the end of the exercise while his counterpart was observed at the beginning. (Note the 64-hour time horizon for the other commander's consideration of his follow-on mission.)

The team predicted greater time horizons for the commander under digitization, but expected that digitization would shorten the length of his decision cycles. The MSF Commander's average time horizons were greater, but his decision cycles were longer. The most likely reason for this result is the different reasoning styles of the commanders.

Decision Cycle Comparisons

		MSF Commander	Other Commander
Decision Cycles:	Number observed	18	12
Trigger Source:	Internal	8	5
	External	10	7
Length:	Range	9 min - 23 hrs	9 min - 19 hrs
Unexpected result	Average	11.5 hours *	5.2 hours
Decisions per Cycle:	Range	1 - 70	1 - 16
	Average	8.9 (5.3) **	4.4
Time Horizon:	Range	30 min - 36 hrs	2 - 64 hours
	Average	19.6 hours *	17.6 hours

No clear evidence of differences attributable to digitization

*First six MSF Commander decision cycles began before observers started; therefore, actual lengths and time horizons are longer.

**Number in parentheses is average calculated without high (70) value. The next highest value for the MSF Commander was 11.

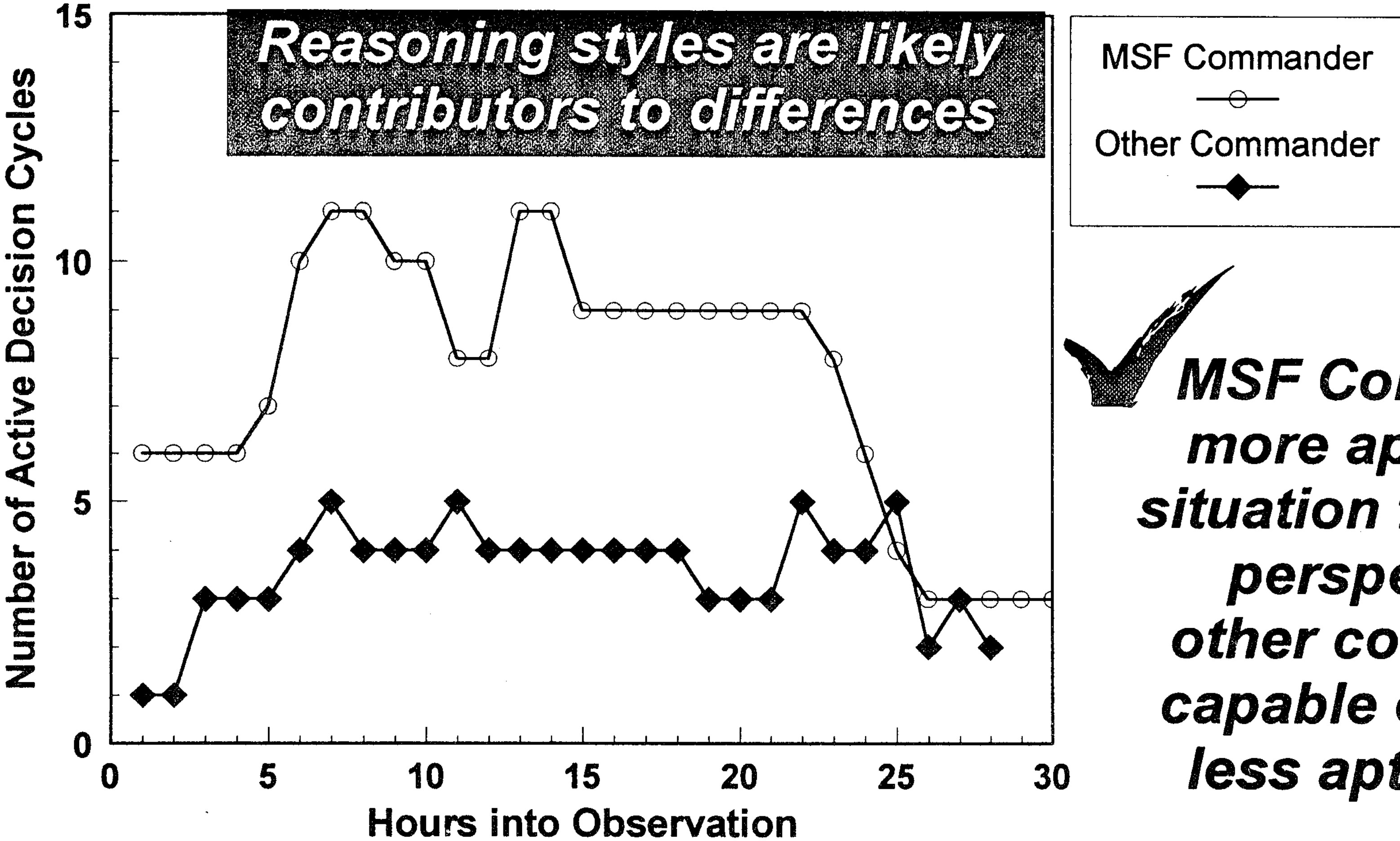
Decision Cycle Comparisons - Concurrent Decision Cycles over Time

The MSF Commander had as many as 11 different decision cycles working at one time. He averaged about 42% of his 18 cycles in process throughout the period of observation compared to about 29% for the other commander. This suggests that the MSF Commander's greater total number of decision cycles does not account for the difference in number of concurrent cycles.

The self-reported problem solving styles indicated that the MSF Commander was more apt to view a situation from many perspectives and organize the inputs into a meaningful whole. This is also suggested by the greater difficulty experienced by the analyst in defining discrete decision cycles for the MSF Commander. For example during the last day of the exercise when he was detailing and executing the "final" plan, separate decision cycles were identified for fire support, logistics, movement to contact, and lateral unit coordination. These were all integrated with the basic maneuver cycle and might have been treated as one very broad cycle involving 97 separate command decisions. For the other commander, establishing discrete cycles was relatively easy as he seemed more apt to handle problems individually. However, he too showed himself, at times, capable of integrating large amounts of information -- he was either relatively less apt to do so, or was faced with a less complex situation compared to the MSF Commander and thus, not required to do so.

Thus both the self-report of styles and observed styles help explain the MSF Commander's ability to hold open a large number of decision cycles: he was very adept at inferring the relationships among objects, events and tasks and creating an integrated picture of the battlefield in his mind. How he appeared to achieve this has important implications for digitization.

Decision Cycle Comparisons - Concurrent Decision Cycles over Time



MSF Commander more apt to view situation from many perspectives; other commander capable of this but less apt to do so

MSF contingency missions added complexity

MSF Commander's Use of Digitization

The counts shown here are for discrete uses regardless of length of time involved. So a formal briefing on the VTC that spans 45 minutes and a discrete interaction that takes less than one minute both count as one instance. Formal uses of the VTC and SPECC are in all cases prepared briefings or planned rehearsals.

These are the only uses of systems recorded for the MSF Commander during those last two and one-half days of the exercise. No interactions with any other system than those shown here were witnessed. With the exception of the VTC and Corps VTC terminals, the team did not see the MSF Commander directly interact with any system, relying upon others to do that. In fact only 11 of his 27 requests for information could at all be construed as requiring use of digitization and these were almost exclusively requested of the G2.

Digital products here refer to hard copy of system-generated outputs. The high use on 23 May is mostly tracking and annotating situation overlays from SPECC intended for the Corps Commander. In fact, 10 of the 12 total interactions with hard copy digitized outputs involved SPECC products.

The chart clearly shows his nearly exclusive use of the VTC and SPECC systems over any others. Note the steady increase in the use of the VTC over time and the corresponding drop in the percent of time he spent at subordinate and higher headquarters. On the last morning he was in a direct fight with the Governor's Vanguard and was operating almost exclusively from the VTC in the Forward CP.

We conclude from this that his preference for battle command aids was primarily for those that permitted verbal communication with others and at least an apparent disinterest in the more generative aspects of digitization. The explanation offered for this is based on the difference between interpretive and generative reasoning styles. These results do not provide conclusive evidence that any one technology improved the MSF Commander's RCP; they are merely observations of his exhibited preferences.

MSF Commander's Use of Digitization

	23 May	24 May	25 May*
Corps VTC Formal	4	2	1
Informal	3	12	27
SPECC Formal	4	5	1
Informal	5	3	4
Corps Terminal	2	3	
BCPS-MapInfo		1	1
Digital Products	8	1	3
% Time Out of Div CP	14	6	4

* half day

Count of Specific Times Digitization Was Used

Observed preference for aids permitting verbal communication, but no conclusive link to improved situational awareness, shorter decision cycles, or broader decisions

Intuition and Digitization

One way to explain the MSF Commander's apparent lack of interest in analysis support is his confidence in his own analysis. A previous chart indicated that he asked fewer "knowledge" questions which might imply greater self-confidence in his own knowledge.

Where the interpretive reasoner considers his own knowledge adequate to explain or provide a reaction to a situation, he tends not to seek outside support. But when his own knowledge structures do not provide an interpretation or solution with confidence, he can prove to be as generative as the more procedural reasoner. One reason is that much of his knowledge base was probably constructed analytically. It is preference and not skill that makes him interpretive.

The only time the MSF Commander was observed to complain about the digitized products was on the last day. He had developed a very detailed COA to meet the threat. In other words, he had a highly interrelated concept mental model. The situation was very fluid and there was an obvious attempt to maintain a situational model to compare with his concept mental model. Time stress and complexity made this extremely difficult to do cognitively. He sought such an integrated picture of enemy, friendly, and terrain situations, but none was available from the digitization at that time.

This last bullet represents probably the most fatal flaw in interpretive reasoning. A classic example of this occurred late in the battle. The MSF Commander had not been too considerate of terrain, but his C/S and Plans Officer pointed out what they said was highly restrictive terrain creating two enemy avenues into the battle area. The MSF Commander rapidly built a concept using this restrictive terrain as a primary element. Three separate experts and the brigade commander on the ground later told him it was not really restrictive. He maintained his concept despite this contradictory evidence. It had become an integral part of a highly interrelated mental model, making it difficult to disregard.

Intuition and Digitization

- More reliance on own internalized knowledge structures means less perceived need for externally-derived assessments

- Relative efficiency and speed of interpretive decisionmaking make it difficult to switch to a more generative approach except where "intuition" does not provide an acceptable answer

- Construction of highly relational mental models of a situation or COA leads to preference for similarly integrated information from the environment

- Construction of highly relational mental models leads to reluctance to accept contradictory evidence, especially regarding the more highly interrelated aspects of the models

✓ ***More difficult to support an interpretive reasoner with digitization than a generative reasoner***

Conclusions

The MSF Commander had minimal direct interaction with the digitization available during the time he was observed. This makes it difficult to attribute to digitization any differences in performance between him and the "non-digitized" commander. Yet considerable differences between the two did exist and the analysis indicated that they were primarily due to differences in reasoning style.

A case has been made for assigning to the MSF Commander what is defined here as an "interpretive" reasoning style. When compared to a "generative" style, the interpretive reasoner is less procedural, his reasoning is usually more rapid and less open to observation, and he works more from internalized knowledge structures and less from external analysis than his more generative counterpart. The effects on use of digitization are apparent. It is easy to support a generative reasoner. He can identify "pieces" of data he wants and how he wants to manipulate them and is fairly consistent across applications. The more interpretive reasoner may be able to use the same bits of information, but his manipulation of them is harder to verbalize and more situation dependent. So any manipulations done on the data that do not match his own mental models are likely to be ignored. To get the more interpretive reasoner to use the full capabilities of digitization, he must either be convinced to be more procedural in his reasoning or have systems that permit very rapid, user-defined manipulations.

What was done here simply compared one student "commander" against another. With just the two of them it is not surprising that individual differences seemed to dominate. Many applications are needed over many individuals to build some confidence in the findings. Controlled observation of actual commanders using digitization in realistic exercises is needed to generalize any findings in the AWE. More controlled laboratory tests are needed alongside the large exercises to better evaluate isolated issues.

Conclusions

Hypothesis: the dominant reasoning style of the MSF Commander can be measured and will interact with digitization in ways to be determined

✓ ***Reasoning style is an important factor in the use of digitization and preference for types of digitization***

Hypotheses:

- Digitization will increase the situational awareness of the MSF Commander
- Increased situational awareness will result both in shorter decision cycles and increased breadth of decisions

✓ ***There were differences between the two commanders, but they are more readily attributed to differences in reasoning style than to effects of digitization***

✓ ***Need to continue testing the application of digitization to battle command***

21st Century Classroom

The Battle Command AWEs provided an environment suitable for postulating characteristics of future classrooms. This section addresses computer literacy as a potential requirement for students in future classrooms, with and without walls.

21st Century Classroom

- *Focus*
  - *Observations*
    - *Achieving Computer Literacy*
      - *Alternative Solutions*
        - *Recommendations*

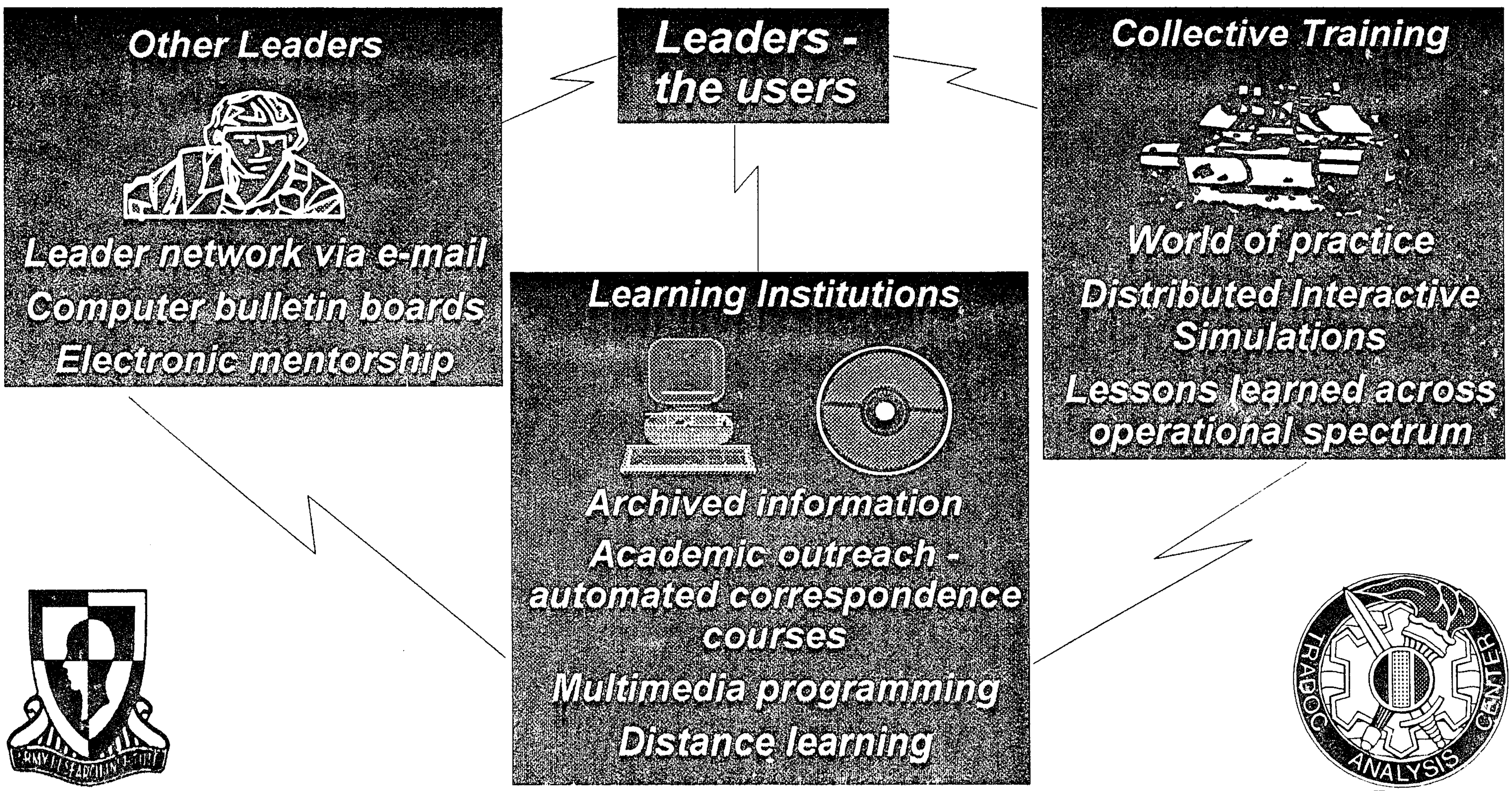
Focus

At the March '94 TRADOC Commanders' Conference, a vision for 21st century training and leader development was discussed by the Deputy Commander, TRADOC. A new paradigm was posed, using an electronic network to link leaders to learning institutions, to other leaders, and to the collective training environment, providing leaders with constant access to information. Commanders were challenged to develop ideas for achieving this linkage, which will surely require users to possess some fundamental personal computer skills. This section focuses on related experiences in the FY94 Battle Command AWEs and provides some possibilities for consideration by the Army.

Focus

- ***Vision for 21st Century Training and Leader Development from March '94 TRADOC Commanders Conference***

Constant access to information



Observations

While no computer literacy test was administered, the very first observations of the BCE students in the January AWE indicated that the assumed levels of computer literacy did not exist. Many students were unfamiliar with a Windows-based environment, and were unable to complete simple file transfer tasks on PCs. Even during Prairie Warrior in May, students were observed developing a plan using unit symbols and graphics on acetate over a map, then inputting that "snapshot" into one of the digital mapping tools. This resembles initial experiences with a word processor: most people start by writing their thoughts on paper, then entering them into a computer, then modifying their document at the keyboard. Eventually, it becomes more efficient to compose at the keyboard, though this may not occur for a considerable length of time.

As the exercises progressed, students could be characterized as shown here. A few students were skilled in the use of PCs, either through home or on-the-job experiences. These students could begin to use many of the hardware and software technologies with little training. Other students were not necessarily computer literate but understood the potential of computers to simplify tasks and were willing to learn. Still others did not know or have any desire to know how to operate a computer.

It is difficult to imagine successful implementation of IO concepts without some basic level of computer literacy in the officer corps. With a smaller Army, dedicated enlisted or civilian operators may not be available for each information system. Further, the promise of voice-activated software, or programs controlled by eye movement may be highly specialized; these approaches may lessen, but probably not negate, requirements for fundamental computer skills.

Certainly, the Army must demand that applications become more "officer literate". Digitization tools must be designed to accommodate the user, within fiscal and technological constraints. The senior Army leaders of 2010 are today's CGSC students, whose computer skills range from proficient to nonexistent. The Army cannot afford to bypass a generation of leaders on the way to Force XXI.

Observations

BCE participants fit into three basic categories:

- Computer literate
- Computer illiterate but trainable
- "Think a computer might make a good boat anchor"

Hypothesis:

YOU CAN'T WIN THE INFORMATION WAR WITHOUT A COMPUTER LITERATE OFFICER CORPS!

- Dedicated "operators" for information systems may be a luxury
- User interfaces must be improved
- Still, basic computer skills will likely be required
- 2010 senior leaders are today's CGSC students

We can't wait to grow computer-literate leaders from lieutenants!

Achieving Computer Literacy

A common-sense approach to introducing computer skills to Army officers through Army educational institutions is offered here, as a proposal for consideration. Educational institutions were chosen because the Army's branch, staff, and command schools reach an exceptional cross-section of the officer population. At the branch schools, the video game generation is arriving. These officers will use computers in nearly all of their future assignments. Officer selections for staff and command schools such as CGSC and the Army War College indicate a high potential for future assignments in increasingly responsible positions of leadership, and represent points at which further investments in computer literacy should have a long-term payoff. This proposal would provide access to COTS hardware and software for each student. The Army inventory of leaders with fundamental computer skills in 2010 may not be adequate if approaches are not pursued beyond the 28-member BCE class.

Through simple actions, such as electronic distribution of class schedules and messages, requirements for electronic submission of assignments, and computer-based testing, these institutions can provide an environment for enhancing computer literacy of officers. Local area network/wide area network (LAN/WAN) connections could be provided in each classroom for each student and in each set of student quarters. Connections could also be provided to the Internet so that students can learn about and access other information sources. Once students are comfortable with basic activities, more complex tasks can be introduced, such as class discussions through PC-based video connections; research using Internet connections; and electronic interviews with senior leaders. The service schools could also provide special applications software to the students to assist them in their course work and future military assignments. These tools may include digital mapping, decision support, planning, allocation and risk assessment tools.

Small offsets in the costs of printing, distribution, and storage may be realized, though these would certainly not be expected to cover the cost of the investments.

Achieving Computer Literacy

In branch, staff, and command schools:

- Additional method of receiving information (textbooks and presentations - recorded or "live")
- Distribution of class schedules
- Distribution of messages
- Testing
- Submission of written assignments
- LAN/WAN connections (classroom and quarters)
  - Surfing the INTERNET
  - Establishing leader networks, electronic mentorship capability
- Additional special applications software
  - Digital mapping, decision support tools, planning, allocation and risk assessment tools - applicable to unit assignments

Potential offsets in printing, distribution and storage

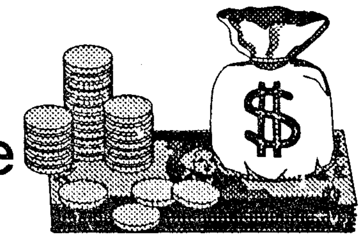
Alternative Solutions

Today's paths to computer literacy are not promising. Use of existing military computers will only reach a fraction of the force due to prohibitive costs. Reliance on self development, judging from the Battle Command AWEs, is a hit-or-miss proposal, and is completely lacking in standardization.

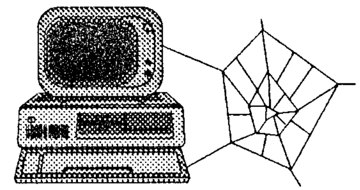
Alternatively, the Army could consider the concept of using COTS hardware and software in academic institutions. A small, lightweight computer such as a laptop with good communications features would fit the needs of most students and institutions. Integrated office automation software packages typically provide word processing, spreadsheet, data base management, graphics package, electronic mail and personal organizer capabilities, and are designed to work together. With careful screening to identify acceptable software packages, skills developed on one package are generally transferable to another package.

Another aspect to consider is a program that either provides this automation package to officers as an issue item, or reimburses the officer for purchase of a computer. The reimbursement program may be able to take the Army out of the procurement process with associated demands for detailed requirements definition, competitive bidding, litigation, legal, and political problems. For example the Army could define a set of capabilities which qualifying vendors must achieve in their products. When students arrive for class, the first order of business could be a computer fair where multiple manufacturers or dealers display and sell their products to the students. Student purchases of minimum capability products could be covered by a basic computer allowance, with costs for any extra capabilities borne by the student. This arrangement provides for a wide selection of hardware products and services while maintaining a degree of control. It also may help develop a broader commercial support base for future private product development and support based upon Army user experience, recommendations and product complaints.

Alternative Solutions



- Use existing Army automation hardware and software



- Rely on officer corps self-development
- Specify a compatible but competitive set of COTS hardware and software products adopted to begin to address Army needs
  - Laptop computer with fax/modem/video/sound card capability
  - Commercial integrated software package such as the Windows-based Lotus SmartSuite, MicroSoft Office, or similar capability
  - Suite of specialized planning tools and decision aids for Army applications

Consider computer allowance versus issuing computers

- May take the Army out of the "procurement" process
- Potential savings in time and money (computer fair, group discounts)
- Provides a wide selection of products and services
- Provides a wide commercial base for future private product development and support

Recommendations

The Army's academic institutions seem to be a logical place to begin developing basic levels of computer literacy, by targeting new officers as well as high potential mid-career officers. The proposal could provide a window to the Army's future operating capability today, in that students would take their computers with them to their next assignment and use them in the same manner they had in their schools, for planning and operations, for maintaining contacts in the leader community, for keeping connected to the institution and other information sources, just as envisioned in the TRADOC leader development and training strategy. Army units could provide the connectivity for all of these computers through LAN/WAN linkages and network/system management, and may eventually reduce their own investments in PCs. The computer allowance or reimbursement might then be renewed every 3 to 5 years to allow officers and the Army to keep up with changes and improvements in technology.

This does not mean that the Army can afford to train only with the information technologies. Students in Prairie Warrior were also observed waiting for information technologies to be fixed rather than using another method to accomplish tasks. Training for operations in a manual mode must not be discontinued.

Recommendations

✓ ***Further investigate computer literacy status and future requirements***

✓ ***Consider a proposal to develop basic computer skills through the Army's academic institutions***

- Army units provide connectivity (LAN/WAN linkages, network/system management), reduce unit computer purchases
- Students take computers with them to their next assignment, accessing:
  - Leader network and learning institutions
- Students use skills and tools in collective training
  - Design compatible linkages from force level data bases/systems
- Consider an allowance/reimbursement with renewal every 3 to 5 years to keep up with changes in technology

✓ ***Do not overlook training for operations with reduced or no digitization support***

AWE Process

This section provides a summary level assessment of the AWE process, as outlined here.

AWE Process

- *Focus*
  - *Characteristics*
    - *Strengths*
      - *Weaknesses*
        - *Conclusions*

Focus

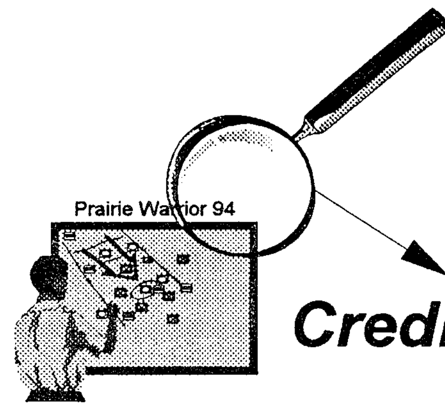
As discussed with experiment limitations, merging future warfighting research with training exercises is a challenge because the objectives are often competing. The training community is interested in assuring that participants achieve recognized standards in a particular set of skills. The experimentation objectives typically replace a subset of the standard processes, equipment, or environment with an alternative. Thus the participants may not achieve all training objectives because of a deliberate lack of opportunity. In the Battle Command AWEs, the MSF replaced many familiar DTLOMS aspects of a heavy division environment. With wholesale substitutions, the initial training objectives may be completely unattainable. Warfighting research and training exercises can be intermingled, but there is a balance to be maintained.

Focus

Design and control the experiment

Develop the warfighter

Doctrine
Training
Leader Development
Organization
Materiel
Soldier



Credible insights

Achieve training objectives

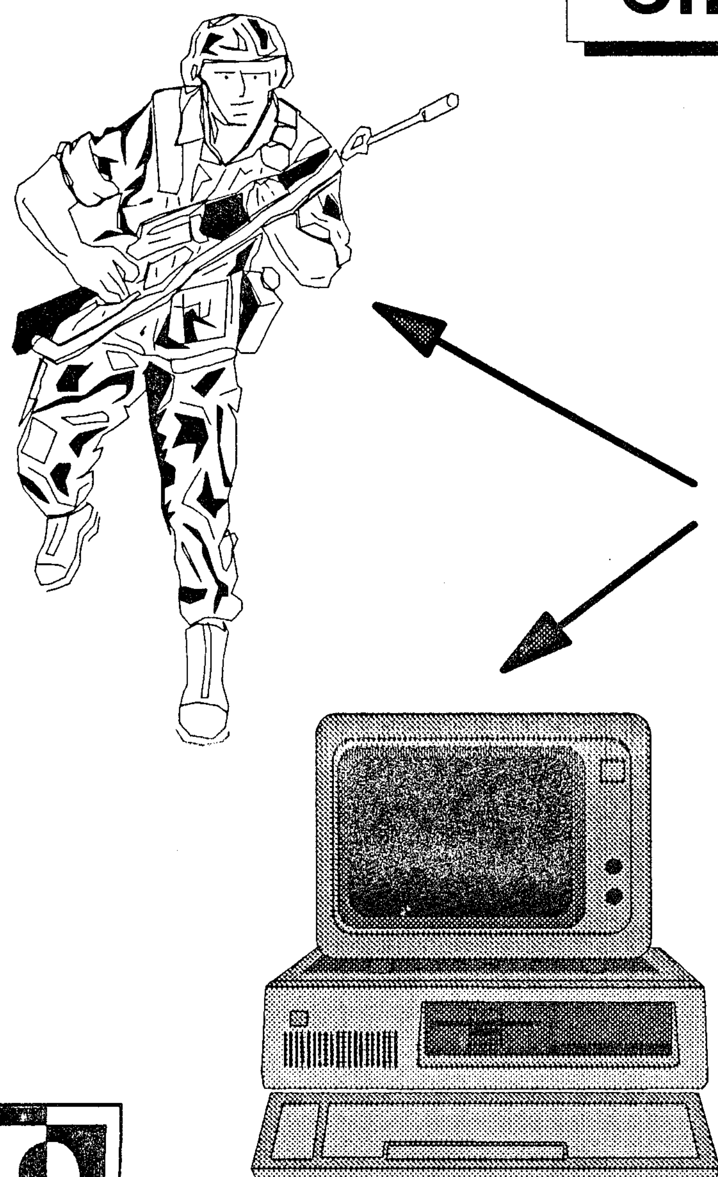
Balance competing objectives!

Characteristics

The Battle Command AWEs were conducted as battle laboratory exercises with CGSC students as surrogate commanders. These students (majors and captains) served as division and brigade commanders and staffs, executing operations beyond their experience levels in terms of their assigned positions, their combined arms competencies, and unit cohesiveness. The students were innovative, thoughtful participants in the experiments, but a broader base of experience may be necessary to adequately address some battle command issues.

The realism the students experienced was linked to the representation of battlefield functions within the exercise driver. No simulation is completely accurate in the portrayal of the situation or the capabilities and effects of weapons, because of aggregation tradeoffs to achieve desired responsiveness of the model. In addition, the students did not experience some of the challenges they would have in a field exercise. To cite some examples, students were not affected by inclement weather; there was no real requirement for around-the-clock capabilities;communications nets were artificially simplified and typically unconstrained; and there were no real time-distance constraints regarding commander/staff interactions on the battlefield, although greater restrictions could have been imposed on movement between warfighting cells.

Characteristics



- Students as surrogate commanders and staff
- Realism linked to simulation driver
- Few NTC/field type challenges (e.g., environmental, CONOPS, communications, transportation)

Strengths

This type of exercise provides the opportunity to examine more factors concerning digitization than possible in a constructive simulation alone. Impact on commanders, leader development challenges, computer competencies, and frustrations with inadequate linkages are all important observations which must be considered in the evolution of IO.

To be most effective, participants must be tactically proficient, and must also be familiar with the experimental systems (in this case information technologies) and trained to use the equipment prior to the exercise. The ability to tailor the CGSC curriculum to meet training and leader development objectives as well as experimental objectives is critical to the success of the Prairie Warrior experimentation process. The BCE participants created a positive environment of unit cohesion that additional students (assigned to the MSF only for Prairie Warrior) were able to build upon. Although there were limitations in terms of numbers of students and amount of time available for pre-Prairie Warrior training, the BCE provided a useful forum to prepare students for a large-scale training exercise in a less costly manner.

Finally, an integrated but diverse support team, including experimenters, educators, analysts, psychologists, combat developers, and specialized contractors, provided a much more robust assessment capability than any single agency. To assist this group, the audio/video monitoring and recording capabilities provided a critical review capability, as well as a less intrusive observation means. Those records of the warfighting exercises may be useful for related analytic, educational, and developmental purposes.

Strengths

- ► Human dimension critical for digitization experimentation
- ► Pre-exercise training (like BCE) provides opportunity for tactical and technical training prior to large-scale exercise
- ► Multi-disciplined, integrated support team provides greater capability than single agency

Weaknesses

One of the weaknesses of the Battle Command AWEs was that the MSF was used to address many experiments unrelated to battle command. The issues of battle command could have been addressed in the context of any notional division, but the importance of the MSF to the Army community dictated that these experiments also use the MSF. The concern with this approach is that the scope of training becomes very great - students must become proficient not only in battle command, staff processes, and information technologies, but in the execution of a new warfighting concept, and in the capabilities and employment of new organizations and weapon systems.

The introduction of experimental issues across the DTLOMS should be accompanied by a commitment on the part of all experimenting agencies for training the participants. This commitment was only made by BCBL.

Some warfighting cells were severely understaffed or mismatched in skills for the Prairie Warrior exercise. This has important implications for experimental design: inadequate staffing means that some functions will not be performed to standard, or perhaps not at all. Experimental issues dealing with staff size, streamlining of staff processes, or similar matters may be difficult to address in such an environment.

Another area to watch is the visibility of the exercise. The leader development opportunities for the students and the publicity aspects for the Army are extremely valuable, but the simulation driver never stopped to accommodate the dozens of general officers and high-ranking civilian visitors to Prairie Warrior. As a case in point, the MSF 1st Brigade Commander reported to the CSA that his unit continued to fight the battle while the CSA received an information briefing from the rest of the division staff. When an experimental issue deals with speed and quality of decisions, it is clear that these kinds of interruptions will have an effect. Another confusing practice was the switching among mentors to the MSF. A single mentor or group of mentors assigned to the MSF for both the BCE and Prairie Warrior would have assisted in maintaining continuity throughout the experiments.

Weaknesses

- MSF complicated battle command experimentation - training mission extended far beyond staff processes and information technologies

- Successful experimentation requires investment by all issue proponents in pre-exercise training, but limited time was available in this pilot program

- Inadequate staffing for some functions

- High visibility good for leader development and publicity, but can undermine experimentation

Process may be unsuitable for some issues

Conclusions

Credible results flow from good experimental design, including screening of issues; control of the experiment to preserve comparison capabilities established by the design; enforced adherence to a fixed end to good ideas; and adequate training of experimental subjects in basic functional competencies required in the exercise as well as all experimental areas.

Conclusions

- *Up-front experimental design and control critical - must say "No" to some issues*
- *"Good idea cutoff point" must precede training*
- *Training of participants must address tactical competencies and all experimental issues*

Summary

Key conclusions and recommendations of the Battle Command AWEs are provided in the summary.

Summary

- *Principal Conclusions*
    - *Key Recommendations*

Principal Conclusions

Even with the enormous changes the Army has seen since the 1985 CCIR survey, students demonstrated that basic elements of information have not changed - that a certain set of information will always be relevant to military operations across the spectrum of warfare. However, the diversity of warfare also demands that flexibility be provided to a commander, to access additional information relevant to his situation and to match his decisionmaking style.

The results of this study show there is a need for the capabilities represented in the information technologies used in the Battle Command AWEs. However, many improvements are needed before the technologies will realize their potential.

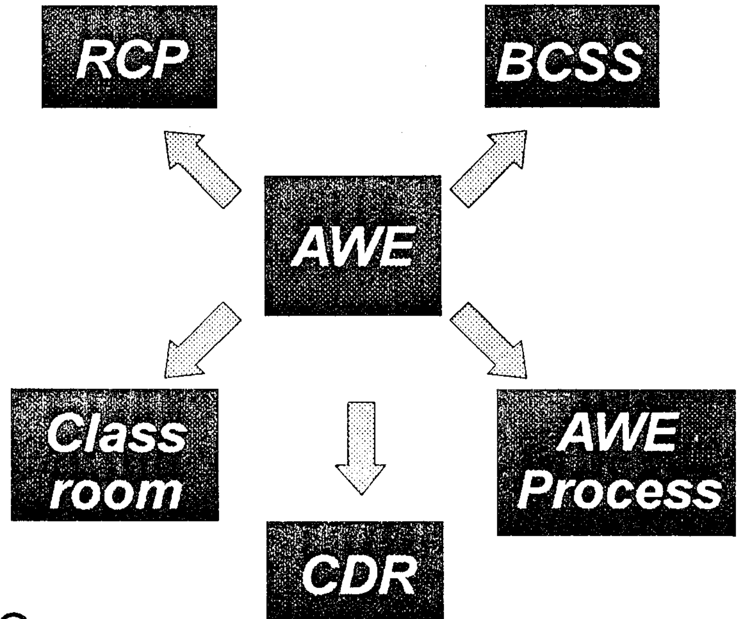
The influence of reasoning style on digitization use and preference may be a "tip-of-the-iceberg" result. Though the effort indicated that differences between the MSF Commander and another division commander were due more to reasoning style than to effects of digitization, the MSF Commander's self-described ability to "connect the dots" (because he was surrounded by the RCP) suggests that we have much to learn about how commanders assimilate information. Reasoning style is just one aspect which happened to come to the forefront here because of the small sample of observations and commanders.

The level of computer literacy of today's staff officers may be inadequate to implement IO. The Army may want to consider altering the training and education process to introduce relevant computer tools in its principal institutions. At a minimum, the Army must demand user-friendly information technologies coupled with standardization/commonality among information systems (icons, tools, environment). This provides portability of experience from one system to another and eases the training burden. Prototype computer applications used in the BCE may be too complex for time-pressured, infrequent use by staff and commanders.

As a first effort, and one which saw a midstream shift from Advanced Warfighting <u>Demonstrations</u> to Advanced Warfighting <u>Experiments</u>, the AWEs provided remarkable insights. Good experimental design and control can improve the AWEs as the issues become more focused.

Principal Conclusions

- There is a timeless set of core information elements for the RCP, and a requirement for a tailorable component -- both rely on a comprehensive force level data base or links to multiple sources
- Computer literacy in the officer corps, and officer literacy in the design of digitization tools, may not be on track to implement IO



- Digitization must be designed from a clear and detailed understanding of tactical reasoning
- VTC, electronic messaging, digital mapping, operational, administrative, and predictive tools provide unique, essential capabilities in developing and sharing the RCP
- Experimental design and control can enhance value of AWEs for addressing issues across the DTLOMS

Key Recommendations

The set of elements identified by students is recommended as a core set for the RCP. Student judgments were validated, and the set shares a high degree of commonality with the CCIR study. Both the core set and the tailorable component of the RCP depend on the existence of a force level data base.

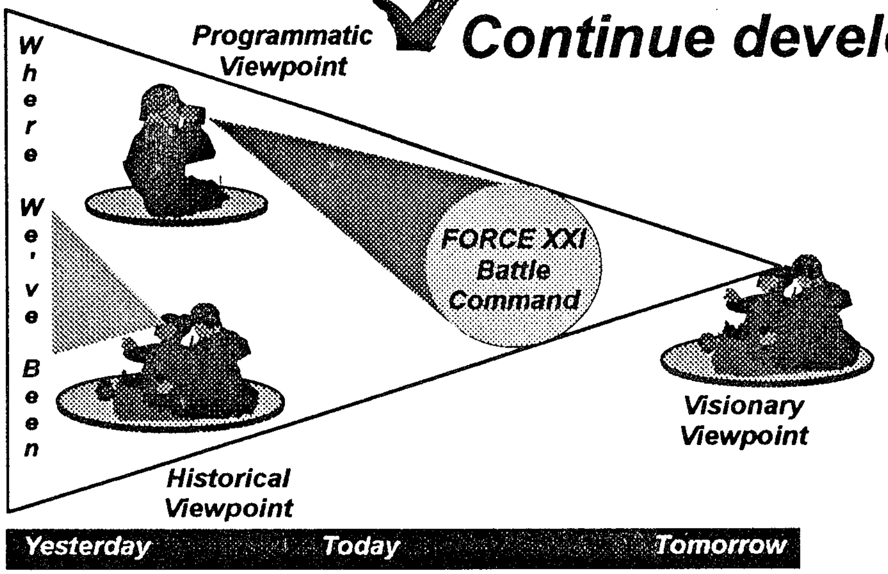
Rather than continue to confirm and make minor adjustments to data elements comprising the RCP, attention should now turn to determining optimal display requirements for the RCP, as well as the tough issues of digital links, automated reporting, and human factors improvements. One of the most frequently mentioned problems with the technologies was the lack of user-friendliness. Even if a system has great capabilities, a poor soldier-machine interface will discourage its use, increase training requirements, increase errors, and in general degrade any performance improvement it might make. The requirement to design systems that are more responsive to the user population is critical. How knowledge is organized in the commander's mind, and influences of reasoning style must be considered in this effort.

While computer literacy requirements for the 21st century are not specifically defined, the Army must ensure that future leaders possess the skills required for battle command of the digitized force of tomorrow.

Finally, continued use of training exercises as vehicles for warfighting research demands that experimental design and control be improved. The AWEs show great promise for advancing the art of battle command; however, the warfighting issues will only get more difficult from this point, as the Army places itself in the future and charts the course ahead. The control mechanisms must be in place to allow valid, rigorous examination of the issues along the way.

Key Recommendations

- Use BCE CCIR as a set of core elements of the division RCP



- Continue development of a force level data base
- Further investigate display requirements for the RCP
- Begin working improvements in digital linkages, human dimensions, and common operating environments
- Continue testing application of digitization to battle command
- Further investigate computer literacy status among Army officers, and requirements for future leaders
- Design experiments to address specific, focused issues

Glossary

3D	three dimensional
AAR	after action review
ACE	analysis control element
ACR	armored cavalry regiment
AES	ATCCS Experimentation Site
ARI	Army Research Institute
ARL	Army Research Laboratory
ARSPACE	Army Space Command
ATCCS	Army Tactical Command and Control System
AWE	Advanced Warfighting Experiment
BCBL	Battle Command Battle Laboratory
BCDSS	Battle Command Decision Support System
BCE	Battle Command Elective
BCPS	Battle Command Planning System
BCSS	battle command support system
BCTP	Battle Command Training Program
BLITCD	Battle Laboratory Integration, Technology, and Concepts Directorate
C2	command and control
C4I	command, control, communications, computers, and intelligence
CAC	Combined Arms Center
CAMEX	Computer-Assisted Map Exercise
CBS	Corps Battle Simulation
CCIR	commander's critical information requirements
CD	compact disk
CECOM	Communications and Electronics Command
CGSC	Command and General Staff College
CL	confidence level
COA	course of action
CONOPS	continuous operations
COTS	commercial off-the-shelf
CoVRT	Commander's Visualization Research Tool
CP	command post
CSA	Chief of Staff, U.S. Army
C/S	Chief of Staff
DMA	Defense Mapping Agency
DTLOMS	doctrine, training, leader development, organization, materiel, and soldiers
EW	electronic warfare
FY	fiscal year
IWEDA	Integrated Weather Effects Decision Aid
LAM	Louisiana Maneuvers
LAN	local area network
LOC	lines of communication
METT-T	mission, enemy, terrain, troops, time available
MPRS	Mission Planning Rehearsal System
MSF	Mobile Strike Force
MSI	Multi-Spectral Imagery
NSC	National Simulation Center
NTC	National Training Center
OPFOR	opposing force
OPSEC	operations security
PC	personal computer
POP-D	Proof-of-Principle Demonstrator
PSYOP	psychological operations
RCP	relevant common picture
RDEC	Research, Development and Engineering Center
SD	standard deviation
SOP	standing operating procedure
SPECC	Space-Enhanced Command and Control System
TRAC	TRADOC Analysis Center
TRADOC	Training and Doctrine Command
VTC	video teleconferencing
WARSIM	Warfighting Simulation
WAN	wide area network

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